Threats to seabirds: a global assessment

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Abstract

We present the first objective quantitative assessment of the threats to all 359 species of seabirds, identify the main challenges facing them, and outline priority actions for their conservation. We applied the standardised Threats Classification Scheme developed for the IUCN Red List to objectively assess threats to each species and analysed the data according to global IUCN threat status, taxonomic group, and primary foraging habitat (coastal or pelagic). The top three threats to seabirds in terms of number of species affected and average impact are: invasive alien species, affecting 165 species across all the most threatened groups; bycatch in fisheries, affecting fewer species (100) but with the greatest average impact; and climate change/severe weather, affecting 96 species. In addition to impacting 86% of globally threatened species, these three top threats also affect 81% of the species currently classified as Near Threatened or as Least Concern but declining. Reversing these three threats would benefit two-thirds of all species and c. 380 million individual seabirds (c. 45% of the total global seabird population). Most seabirds (c. 70%), especially globally threatened species, face multiple threats. For albatrosses, petrels and penguins in particular (the three most threatened groups of seabirds), it is essential to tackle both terrestrial and marine threats to reverse declines. As the negative effects of climate change are harder to mitigate, it is vital to compensate by addressing other major threats that often affect the same species, such as invasive alien species and bycatch, for which proven solutions exist.

Keywords: conservation; globally threatened species; human impacts; marine birds.

1. Introduction

Seabirds are one of the most threatened groups of birds (Croxall et al., 2012; BirdLife International, 2018a). They are also regarded as good indicators of the health of marine ecosystems (Piatt and Sydeman, 2007; Parsons et al., 2008), and have a key role in marine ecosystems, with an overall consumption of biomass of the same order of magnitude as global fisheries landings (Brooke, 2004; Cury et al., 2011). They occur across all oceans, from coastal areas to the high seas, and are easier to study than most other marine animals because they are readily visible at sea and depend on land to breed, allowing for a better understanding of their population trends and of their threats.

The latest assessment of the global threat status of seabirds, using the International Union for Conservation of Nature (IUCN) Red List criteria, revealed that 31% of all seabird species are globally threatened (i.e. Critically Endangered, Endangered or Vulnerable; 110 of 359 species), and another 11% (40 species) are Near Threatened (NT) (BirdLife International, 2018b; Figure A1, Appendix 3). Additionally, almost half of all species (47%) have declining population trends (BirdLife International, 2018b). Some of the drivers of these declines are threats faced at the colonies, such as invasive alien species (Spatz et al., 2014, 2017), whereas others operate at sea, including incidental mortality (bycatch) in fisheries, and overfishing (Žydelis et al., 2009; Anderson et al., 2011; Grémillet et al., 2018). Most previous reviews of threats to seabirds have focused on the causes of declines of specific groups, e.g. albatrosses (Phillips et al., 2016), petrels (Rodríguez et al., 2019), penguins (Borboroglu and Boersma, 2013; Trathan et al., 2015), or on the impact of a single threat, e.g. longline or gillnet bycatch (Anderson et al., 2011, Žydelis et al., 2009). The only global review to date was based on data up to 2010 and focused only on globally threatened seabirds (Croxall et al., 2012). However, to understand the conservation status of this group worldwide, it is important to assess the anthropogenic and natural pressures affecting all species, since many relatively abundant and widespread species of Least Concern on the IUCN Red List are now also in decline (e.g. Little Auk *Alle alle*, Fort et al., 2013; Chinstrap Penguin *Pygoscelis antarcticus*, Korczak-Abshire et al., 2012; Arctic Tern *Sterna paradisaea*, Burnham et al., 2017).

We present the results of the first quantitative review of the threats affecting all seabird species globally. We used data from more than 900 publications and a standardised assessment approach (the IUCN Red List Threats Classification Scheme; IUCN, 2012; Salafsky et al., 2008), aiming to: a) identify the main ongoing drivers of population declines of seabirds globally; b) provide the first systematic appraisal of the overall impacts of each threat on multiple species; c) quantify the number of individual seabirds exposed to each threat; and d) highlight some of the challenges and priority actions needed and to improve the conservation status of seabirds.

2. Materials and Methods

2.1. Selection and categorisation of species

We followed the taxonomy used by BirdLife International for the IUCN Red List (del Hoyo et al., 2014; BirdLife International, 2018b) and considered seabirds to be those species for which a large proportion of the population rely on the marine environment for at least part of the year (Croxall et al., 2012). This criterion was met by 359 extant species (list available at BirdLife International, 2018b and in Appendix 1). We grouped species based on taxonomy: albatrosses; large petrels and shearwaters; gadfly petrels (genera *Pterodroma and Pseudobulweria*); storm-petrels; other small petrels; penguins; auks; skuas; terns; gulls; frigatebirds and tropicbirds; gannets and boobies; cormorants and pelicans; sea ducks and allies; phalaropes (Appendix 1). We also split species into "pelagic" and "coastal" based on the definition provided by Croxall et al. (2012): "pelagic seabirds" are those that primarily use marine deep water (typically >200 m in depth), or neritic, continental shelf water; and "coastal seabirds" are those that primarily use inshore waters (typically <8 km from the shoreline; see Appendix 1). The global

population trend of each species was also used in some analyses (using two categories: declining versus stable/increasing/unknown; BirdLife International, 2018b).

2.2. Data sources and threats classification

For the first time, threats were systematically assessed for all 359 seabird species. We undertook a detailed review of the seabird threat data, held by BirdLife International, which are used to support the global status assessment of bird species for the IUCN Red List (BirdLife International, 2018b), and the consistency of threat scoring between species was rigorously checked. We collected data through a combination of expert consultation (in collaboration with the respective seabird IUCN Species Survival Commission (SSC) Specialist Groups) and a comprehensive bibliographic search for studies reporting threats to each seabird species. In a first stage, we consulted summary species accounts published in the Handbook of the Birds of the World Alive (HBW Alive, 2018), supplemented by regional accounts from the Birds of North America (BNA online, 2018), New Zealand Birds Online (NZ Birds Online, 2018) and the Australian Government Species Profile and Threats Database (Department of the Environment and Energy, 2018). Secondly, we conducted searches in Web of Knowledge and Google Scholar, first using the *species name* (scientific name and common name separately) + "threat", and then using the *species name* and each threat named in the results of the preceding search. For species listed under the Agreement on the Conservation of Albatrosses and Petrels (ACAP), the ACAP Secretariat and relevant working groups reviewed the revised threat codings, and for penguins, the IUCN SSC Penguin Specialist Group performed this role, allowing the incorporation of additional literature and unpublished data. Overall, information from over 900 publications (each referenced to the appropriate species in the factsheets available on the BirdLife Data Zone; BirdLife International, 2018b) was used to revise the 'threats' texts that form part of the IUCN Red List factsheets and assessments (BirdLife International, 2018b).

Threats were classified using the IUCN Red List Threats Classification Scheme version 3.2 (Salafsky et al., 2008; IUCN, 2012). This scheme defines threats as "the proximate human activities or processes that have impacted, are impacting, or may impact the status of the taxon being assessed. Direct threats are synonymous with sources of stress and proximate pressures" (IUCN, 2012). In other words, and in the context of this study, a threat is a human activity or other process that affects the current conservation status of a species by causing a population or range reduction.

Each threat was coded initially using the IUCN Red List Threats Classification Scheme, down to Level 3 (the most detailed classification level) where possible (IUCN, 2012). For each threat, we assessed: 1) timing (i.e. ongoing; past but likely to return; past and unlikely to return; future); 2) scope (i.e. the proportion of the total population affected: minority (<50%); majority (50-90%); whole (>90%)); and 3) severity (i.e. the rate of population decline caused by the threat within its scope: very rapid; rapid; slow but significant; negligible; causing/could cause fluctuations) (IUCN, 2012 and Table 1). Each threat at the most detailed level can be recorded only once against a species, with the exception of 'Invasive & other problematic species, genes & diseases', for which an entry for each problematic species is possible. As one threat can have different timing and severity across the range of a species, the following convention was applied: 'Ongoing' threats were prioritised over 'Future' threats, which were prioritised over 'Past' threats. Hence, a slow, ongoing reduction was coded in preference to a rapid, past reduction. Stresses, which are the mechanism by which a threat directly or indirectly impacts the species, such as species mortality or ecosystem degradation, were also recorded as part of the IUCN threat assessment approach (IUCN, 2012). Further relevant detail beyond that required for the IUCN assessment was also noted when available, in particular the type of fishing gear and the scale of the fishery (small versus large) associated with the impact of bycatch. Overall, this process resulted in the compilation of 1,637 records of threats to 359 seabird species.

The IUCN Red List Threats Classification Scheme was developed to be applied across all species of plants, animals and fungi, and thus often lacks resolution when applied to a specific group. For example, bycatch and overfishing, two frequent threats to seabirds (Croxall et al., 2012), are allocated the same threat code under the IUCN scheme (Level 1 = Biological Resource Use, Level 2 = Fishing &

harvesting aquatic resources, and Level 3 = Unintentional effects). We therefore refined the threats classification by splitting: 1) "Biological resource use" into: "Bycatch", "Overfishing", "Disturbance", "Hunting/trapping" and "Logging & wood harvesting"; 2) "Invasive and other problematic species, genes & diseases" into "Invasive alien species" and "Diseases"; 3) "Agriculture & aquaculture" into "Agriculture" and "Aquaculture"; and 4) "Light pollution" from "Pollution" (see Appendix 2 for a more detailed explanation). We assumed the same impact score of "bycatch" and "overfishing" for species affected by both (n=34), as it was not possible to distinguish their relative impacts (see above). The final list of threats considered in the analyses (Table A2.1, Appendix 2) was thus a combination of the original IUCN Red List classification of Level 1 threats (IUCN, 2012), modified as indicated above (see also Table A2.2, Appendix 2).

2.3. Data analysis

All the analyses (except where noted otherwise) considered only threats that were coded to the timing category "ongoing", with a known and non-zero scope and severity. We also analysed the threats separately for "pelagic" and "coastal" species, and for specific groups of seabirds (see section 2.1. above). For these latter analyses, we distinguished terrestrial threats (e.g. invasive alien species, disturbance at colonies) from marine threats (e.g. overfishing, bycatch). Climate change/severe weather was considered in a separate category; see Table A2.2, Appendix 2 for more details on threats classified as marine or terrestrial). We estimated the impact of each ongoing threat on each species by multiplying the mean scope (the proportion of the population affected; see Table 1) by the mean severity (Table 1; Garnett et al., 2018), and categorised these into four levels, from "low" to "very high" (Table 1). For threats with multiple coding per species (see above), we used the highest value of impact. We also calculated the overall impact of each threat by summing the impact scores across all species.

Finally, we estimated the total number of birds (T) exposed to each threat (i) by summing the product of the global abundance of each species affected by the threat, and the scope of the threat,

$$T_i = \sum_{sp=1}^{n} A_{sp} * S_{i,sp}$$

where *A*=abundance of species *sp*, S=scope of the threat *i* to species *sp*. The global abundance of each species was extracted from the IUCN Red List database (BirdLife International, 2018b) by multiplying the number of mature individuals (available for 95% of the species) by 1.5, to account for the number of non-breeders in the population (Brooke, 2004). In order to address the uncertainty associated with this estimate (given the large range of most estimates of abundance and of the values of scope – see Table 1), we applied a bootstrap approach (1,000 repetitions), by selecting random values within the intervals of abundance (i.e. between the minimum and maximum abundance) and scope (i.e. a random value between the minimum and maximum scope for each category – see Table 1) of each species, from which we derived a 95% confidence interval. These analyses were carried out separately for species classified as: 1) globally threatened; 2) Near Threatened and Least Concern with a declining trend and 3) Least Concern with a non-declining trend.

3. Results

3.1. Threats to all seabird species

Invasive alien species, bycatch, hunting/trapping, climate change/severe weather and disturbance are the ongoing threats affecting most seabird species, with each affecting more than a fifth of all species (Figure 1 and Table 2). Pollution, overfishing and problematic native species also affect many seabird species (more than 50 each; Figure 1). Bycatch, invasive alien species, overfishing and climate change/severe weather are the threats causing highest impacts on average (Figure 1 and Table 2). The impacts of hunting/trapping and disturbance are relatively low by comparison (Figure 1 and Table 2); in contrast, diseases and natural system modifications have high impacts on the few species affected (15 and 10 species, respectively; Figure 1). Invasive alien species have the highest overall impact (i.e. the

sum of all impacts on all species affected by this threat), followed by bycatch and climate change/severe weather (Table 2).

We estimate that more than 170 million individual birds (> 20% of all seabirds) are currently exposed to the individual impacts of bycatch, invasive alien species and climate change/severe weather (Figure 2), and that together more than 380 million (c. 45% of all seabirds) are exposed to at least one of these three threats.

Overall, 301 (84%) of the 359 seabird species are impacted by at least one ongoing threat. About 70% of these are affected by at least two threats and 46% by at least three threats (n=301). On average, each seabird species is affected by three ongoing threats (2.85±0.12, range=1-11, n=301).

3.2. Threats to globally threatened species

The 110 globally threatened seabird species are largely affected by the same threats highlighted above – invasive alien species, bycatch, climate change/severe weather, hunting/trapping and overfishing (Figure 3 and Table 2; see also Figure A2 in Appendix 3). Problematic native species are also a major threat for globally threatened species, both pelagic and coastal. Disturbance is the threat affecting most coastal species, along with hunting/trapping, although mainly with medium or low impact (Figure 3).

3.3. Threats to Near Threatened and declining Least Concern species

Invasive alien species, climate change/severe weather, bycatch and hunting/trapping are also the threats affecting the highest number of Near Threatened (NT) and Least Concern (LC) species with a declining trend; each affects >30% of the species in this group (Figure A3 in Appendix 3).

The populations of these species comprise nearly half of all individual seabirds in the world (45%-47%); about half of birds exposed to some of the major threats (especially bycatch, climate change/severe weather and invasive alien species) are NT and declining LC (Figure 2); 81% of the species currently NT or LC with declining trends are impacted by at least one of these three threats.

3.4. Threats to groups of seabirds

The major threats to particular groups of highly threatened species are indicated in Figure 4 (see also Figure A4, Appendix 3, for the percentage of threatened species per group). Albatrosses are particularly affected by bycatch (90% of species). In addition, around half of albatross species (13 of 22) are affected by at least one terrestrial threat, mostly invasive alien species but also diseases, which have a high impact (Table 3), and over one-third are affected by climate change/severe weather.

More than 80% of penguin species are affected by climate change/severe weather (a higher proportion than any other seabird group). Marine threats such as overfishing, bycatch and pollution also have large impacts on several species of penguins (Figure 4). The main threats at colonies are invasive alien species, problematic native species and disturbance, albeit with lower estimated impacts on average. Around half of the penguin species suffer medium, high or very high impacts from both marine and terrestrial threats (marine – pollution or overfishing; terrestrial – usually problematic native species; Table 3).

Invasive alien species and bycatch are also important threats for large petrels and shearwaters (eight species are affected by both these threats; Table 3), as is light pollution (Figure 4). Cormorants and pelicans are also impacted by a combination of several terrestrial (including invasive alien species and problematic native species) and marine threats (bycatch, overfishing and pollution; Figure 4 and Table 3). In contrast, gadfly petrels and storm-petrels are almost exclusively impacted by terrestrial threats, particularly by invasive alien species (and light pollution in the case of gadfly petrels; Figure 4).

3.5. Invasive alien species

Rats *Rattus* spp. and cats *Felis catus* are the invasive alien species impacting the highest number of seabird species (more than 100 and 90, respectively; Figure 5). Sixty-three seabird species (38% of those affected by invasive alien species) are impacted by both rats and cats. Mice (*Mus* spp. and *Peromyscus maniculatus*) affect a smaller number of species (22, of which 20 are Procellariiformes - albatrosses, large petrels & shearwaters, gadfly petrels, prions and storm-petrels), but often with high severity.

3.6. Bycatch

Large-scale fisheries are causing declines of most species affected by bycatch (> 80), whereas < 40 species are affected by small-scale fisheries; Figure 6). The average impacts (scope and severity) of large and small-scale fisheries are, however, similar (Figure 6). Gillnet fisheries affect more species than longlining and trawl fisheries; these last two gear types have, however, a greater impact in terms of both average severity and scope (Figure 6).

3.7. Climate change and severe weather

Climate change/severe weather impacts seabirds mostly due to habitat shifting and alteration, and temperature extremes (almost 40 species are affected by each of these threats, and with relatively high scope; Figure 7). Storms/flooding impact more than 20 species of seabirds, and with lower scope (Figure 7).

Species impacted by climate change are also affected by three other threats on average (2.99±0.2; mean ± SE), including invasive alien species (52%), bycatch (43%), and c. 30% by each of overfishing, hunting/trapping and/or pollution (Figure A5, Appendix 3). For only 11% of seabird species is climate change/severe weather the only threat.

4. Discussion

This is the first comprehensive analysis to use consistent, objective criteria to assess the threats to all 359 seabird species worldwide. We found that invasive alien species, bycatch and climate change/severe weather are the top three threats to seabirds in terms of the number of species affected (165, 100 and 96, respectively; Figure 1), overall impacts (Table 2), and the estimated total number of individual birds potentially affected (Figure 2). Hunting/trapping and disturbance also affect many species (97 and 73, i.e. 27% and 20%, respectively), but with a low impact on average; conversely, overfishing has a relatively high impact on fewer species (54, i.e. 15%).

A comparison with the threat assessment made in 2010 is possible for globally threatened species (Croxall et al., 2012), despite minor changes in the list of species, and some differences in methods (e.g. checks for consistency in scoring threats across groups were not made in the previous study). Our results confirm the persistence of top threats such as invasive alien species and climate change/severe weather, which still affect a similar number of species (Figure 8). Threats related to fishing have increased since the previous assessment, with bycatch now impacting 50 rather than 40, and overfishing 22 rather than 10 globally threatened species (Figure 8). This is partly due to better understanding of the impacts of gillnet fisheries on seabirds (Žydelis et al., 2009; Crawford et al., 2017), especially coastal species such as sea ducks (Žydelis et al., 2009), including some species which have recently been uplisted to globally threatened (e.g. Long-tailed Duck *Clangula hyemalis*, Horned Grebe *Podiceps auritus*). The relevance of overfishing has also increased, both in pelagic and coastal species (e.g. penguins and cormorants; e.g. Crawford et al., 2015; Trathan et al., 2015). In contrast, the threat from marine pollution has decreased, now affecting 23 rather than 30 globally threatened species. The threat from pollution is largely related to oil spills, a well-known and conspicuous threat to seabirds during the 1970s and 1980s. Oil spill events has decreased greatly in recent decades (Roser, 2018), with a consequent predictable reduction of its impact on seabirds when compared with the situation at the end of the last century (Camphuysen, 1998; Clark, 1984).

The top threats currently affecting globally threatened species largely coincide with those affecting NT and LC species with declining trends (Table 2 and Figures A2 and A3, Appendix 3), which represent one third of all species, and half the total number of individual seabirds. Therefore, tackling the current major problems faced by globally threatened species will also reduce the exposure of hundreds of millions of other (currently non-threatened) seabirds to these threats (Figure 2).

4.1. Major threats on land

Our study highlighted that invasive alien species, particularly rats and cats, are the major threat to seabird species globally. Therefore, eradication or control of rodents and cats is the major priority in terms of conservation of seabirds at their colonies (Phillips et al., 2016; Spatz et al., 2017; Holmes et al., 2019; Rodríguez et al., 2019) along with enhanced biosecurity measures to prevent re-invasion or new introductions (particularly for sites in proximity to human habitation) and, if necessary and where feasible, post-eradication restoration to provide habitat suitable for recruiting additional seabirds to now-safe sites (Borrelle et al., 2018). The frequent co-occurrence of rats and cats poses an additional challenge in requiring simultaneous eradication (Zavaleta et al., 2001; Rayner et al., 2007).

Hunting/trapping at colonies is the second major threat on land in terms of number of species affected, and the top threat to coastal globally threatened species. This is a well-known issue (Chen et al., 2009; Gaston and Robertson, 2010; Merkel et al., 2014, 2016; Phillips et al., 2016), and needs to be addressed in close collaboration with local communities and authorities. Hunting/trapping can also occur at sea (Bugoni et al., 2008; Alfaro-Shigueto et al., 2016; Frederiksen et al., 2016), although impacts are poorly known (Phillips et al., 2016). Disturbance is also a relevant threat in terms of number of species affected globally, and coastal globally threatened species are particularly affected (Figure 3). Disturbance of seabirds at their colonies can lead to reduced breeding success (Giese, 1996; Bolduc and Guillemette, 2003; Watson et al., 2014) or even to permanent abandonment of the site (Carney and Sydeman, 1999). The increase of ecotourism activities can pose an additional challenge (Palacios et al., 2018), which is nonetheless solvable by implementing the necessary regulations to control the access to important seabird colonies (Ellenberg et al., 2006).

Other relevant threats on land are light pollution (affecting mostly gadfly petrels, large petrels/shearwaters and storm-petrels (Rodríguez et al., 2017, 2019), problematic native species (especially for cormorants/pelicans, storm-petrels and penguins) and diseases (affecting mostly albatrosses and penguins). These threats also have some known and implementable solutions, such as avoidance or minimization of light sources (especially during fledging periods in high-risk areas; Gineste et al., 2017; Rodríguez et al., 2017), artificial nests for problematic native species competing for nesting burrows (Bolton et al., 2004), and vaccination against diseases in critical cases (Bourret et al., 2018).

4.2. Major threats at sea

We confirmed that bycatch is still a major threat to albatrosses, large petrels/shearwaters and penguins (Trathan et al., 2015; Phillips et al., 2016), and found that large-scale fisheries are driving declines in more than twice as many species as small-scale fisheries (Figure 6). Although the average impacts (scope and severity) of large and small-scale fisheries seem to be similar, impacts from small-scale fisheries are generally less well-known (Lewison et al., 2004; Chuenpagdee et al., 2006; Soykan et al., 2008). Longline and trawl fisheries involve the gear types with greatest impact in terms of both average severity and scope (especially for albatrosses and large petrels/shearwaters; Tuck et al., 2001; Barbraud et al., 2009).

Many studies have shown that bycatch in longlining and trawl fisheries can be mitigated effectively with the implementation of operational and technical measures. Depending on the characteristics of the fishery, location, season and associated at-risk seabird species, single measures can be effective, such as discard management or bird-scaring lines on trawl vessels (Bull, 2007; Pierre et al., 2012; Maree et al., 2014; Tamini et al., 2015) and hook-shielding devices in pelagic longline vessels (Sullivan et al., 2018). However, measures used in combination are most effective, such as night setting, bird-scaring lines and weighted branch lines for longline vessels (Brothers et al., 1999; ACAP, 2017a, 2017b, 2017c; Domingo et al., 2017; Paterson et al., 2017).

Many Regional Fisheries Management Organisations (RFMOs), and some national fisheries bodies in areas with high bycatch rates, have adopted regulations that seek to minimize bycatch (Anderson et al., 2011; Gilman, 2011; Phillips et al., 2016). The challenge, however, is ensuring practical implementation of the measures and compliance with the regulations, which requires industry-specific solutions and support to ensure validity of the measures and avoid cross-taxa effects (Gilman et al., 2005; Melvin et al., 2019). Gillnet fisheries are thought to affect more species (Figure 6), especially diving seabirds such as sea ducks and auks (Žydelis et al., 2009). However, and in contrast with the

situation for the fishing gears mentioned above, solutions for gillnet bycatch remain elusive and should be regarded as research priorities (but see Mangel et al., 2018; Melvin et al., 1999).

Overfishing is also a top marine threat. It affects fewer species than other top threats, but with considerably greater impact (Figures 1, 2, Table 2). Overfishing is the main cause of decline of 24 species (e.g. Bank Cormorant *Phalacrocorax neglectus* and Cape Cormorant *Phalacrocorax capensis*; Crawford et al., 2008, 2015); and is often associated with bycatch (more than 60% of the species impacted by overfishing are also affected by bycatch). Tackling the problem of overfishing may involve the creation of Marine Protected Areas (Hyrenbach et al., 2000; Lascelles et al., 2012), including no-take zones (seasonal or permanent) in some critical cases (Daunt et al., 2008; Pichegru et al., 2010). However, it chiefly requires the effective implementation of ecosystem-based management of forage-fisheries within the context of wider, multi-stakeholder Marine Spatial Planning (Ardron et al., 2008).

4.3. Scope and scale of management approaches

Many seabird species are impacted by both marine and terrestrial threats, and a subset of these (72 species, including 38 globally threatened species and 20 NT) have at least one marine and one terrestrial threat of medium or higher impact. For example, 27 species are impacted by both invasive alien species and bycatch (particularly albatrosses and large petrels/shearwaters, but also some auks and sea ducks; Table 3). Half of the penguin and auk species face a terrestrial and a marine threat with a medium to very high impact (usually invasive alien species or problematic native species and pollution; Table 3). The co-occurrence of medium or high impact terrestrial and marine threats emphasises the need for "ridge to reef" approaches (Rude et al., 2016; IUCN, 2018), whereby management plans aiming to protect seabird species and their habitats should necessarily include measures to address threats both on land and at sea. The appropriate measures at sea depend on the species and the relevant spatial scales of their foraging ranges: whereas short-ranging species such as cormorants and some penguin species benefit most from site-based forms of protection (e.g. well-managed Marine Protected Areas), wide-ranging species such as albatrosses, petrels and shearwaters will also require measures at the larger scale (even Large Marine Ecosystem; Sherman et al., 2003), particularly in relation to effective fisheries management, notably bycatch regulations (Oppel et al., 2018).

4.4. Climate change

Most of the top threats already mentioned (invasive alien species, bycatch, hunting/trapping, disturbance and overfishing) have known and tested solutions, at least in principle and in part. Climate change/severe weather are different in that there is limited prospect of direct mitigation of most of the main known or potential impacts. These include changes in oceanographic processes (resulting in declining in food availability around colonies), increased frequency of extreme weather events, inundation of colonies due to sea level rise or severe rainfall storms, or increased occurrence and virulence of avian pathogens (reviewed by Grémillet and Boulinier, 2009; Barbraud et al., 2012; Sydeman et al., 2012; Phillips et al., 2016). Translocations (and managed retreat) are a possibility in some cases (Deguchi et al., 2014; Miskelly et al., 2009), but challenging to execute for many species, due to the high costs and logistical difficulties.

Nevertheless, we show that most species (89%) affected by climate change/severe weather are also affected by other threats (3.37 ± 0.2 threats on average ± SE), whose impacts are of the same order of magnitude. The most frequent threats co-occurring with climate change/severe weather are invasive alien species, bycatch, overfishing and hunting/trapping (Figure A5, Appendix 3). This emphasises the crucial importance of addressing effectively these other major threats in order to compensate for the negative impacts of climate change.

4.5. Emerging threats

The problem of marine plastics, which is global and increasing (Ryan et al., 2009; Kühn et al., 2015), and expected to affect virtually all seabird species in a few decades (Wilcox et al., 2015), is not yet identified as a cause of seabird population declines, with only one report so far of plastics causing a significant

impact at this level (Flesh-footed Shearwater *Ardenna carneipes*; Lavers et al., 2014). This threat is predicted to have a higher impact on small, highly pelagic species (such as storm-petrels, prions and auklets; Wilcox et al., 2015; Roman et al., 2019), whose population sizes and demography are mostly unknown, indicating the difficulty in understanding the real impact of plastics at population levels. However, this problem is recent and so a delay would be expected before population impacts become evident for long-lived species, such as most seabirds.

The occurrence and virulence of avian pathogens is also likely to increase, especially at high latitudes, due to the enhanced spread of ectoparasites as a consequence of a warmer climate and to increasing human presence at seabird colonies (Grémillet and Boulinier, 2009; Uhart et al., 2018).

Offshore wind farming (classified here as "Energy production & mining") is another fast-growing issue with potential high impacts on seabirds (Furness et al., 2013), but still with limited information regarding the consequences for seabirds at the population level (Green et al., 2016). This threat is expected to affect mostly coastal species such as divers, scoters, terns and shags (Garthe and Hüppop, 2004), especially via displacement (Furness et al., 2013; Cook et al., 2018). However, highly mobile species can also be at particular risk, due to the cumulative impact resultant from multiple windfarms located across the species distributional range (Busch and Garthe, 2018)

Finally, we anticipate that in a few decades overfishing may become an even more widespread and serious problem for seabirds, including even the more pelagic species. The number of globally threatened species affected by overfishing has more than doubled since the previous assessment based on data collected up to 2010 (Croxall et al., 2012). Depletion of food resources is already regarded as the major cause of decline of 24 species (Table 2), and pressures on stocks of currently exploited coastal forage-fish species are certain to intensify, to the likely detriment of seabirds (Grémillet et al., 2018). In addition, this problem has the potential to increase with the transition of more fisheries to lower trophic levels (Pauly et al., 1998), especially those targeting mesopelagic species (St. John et al., 2016). Mesopelagic fishes, an important part of the diet of many pelagic seabirds (Watanuki and Thiebot, 2018), are the most abundant marine vertebrates (Irigoien et al., 2014) and remain largely unexploited commercially due to the currently low profitability of fishing deep-water species, especially on the high-seas (St. John et al., 2016; Webb et al., 2010). This situation may soon change due to investment in new fishing technologies, along with the increasing demand for these resources from the aquaculture industry (St. John et al., 2016), with potentially serious implications for their current natural consumers (including seabirds).

5. Conclusions

Our analysis shows that invasive alien species, bycatch and climate change are the top three threats affecting seabirds globally. Together these threats affect two-thirds of seabird species and hundreds of millions of individuals. Hunting/trapping and disturbance affect many species, but with lower impacts, whereas overfishing affects comparatively few species, but with higher impacts. The relative importance of these top threats was largely consistent across different taxonomic groups of seabirds, and when considering only globally threatened species or only NT and declining LC species.

Multiple threats often affect the same species; consequently: a) management approaches tackling simultaneously both marine and terrestrial threats are essential to reverse the declining trend of numerous threatened seabird species; b) the negative effects of climate change can be greatly alleviated by addressing other top threats such as invasive alien species and bycatch, for which implementable proven solutions are largely available. However, even for invasive alien species and bycatch, there are substantial challenges to overcome. For invasive alien species, many of the priority eradications (Holmes et al., 2019) for islands uninhabited by humans have been completed. Therefore, the focus will increasingly shift to islands with human populations and to mainland areas, both posing substantial problems in relation to mortality of non-target species and control of invasive alien species (as opposed to rapid eradication), which likely require complex, long-term and costly initiatives, even where inherently feasible (Phillips, 2010; Oppel et al., 2011).

Technical solutions to gillnet bycatch have proven hard to develop; in most longline and trawl fisheries compliance with recommended mitigation regulations remains limited (Phillips et al., 2016). Use of remote-recording electronic devices to monitor compliance may be essential to making progress. Seabirds are increasingly impacted by overfishing, especially coastal species. Theoretically, effective ecosystem-based management of marine resources around important seabird colonies can mitigate problems for these particular species, but also requires that effective plans and processes are in place to monitor and enforce compliance. Such potentially effective management systems remain elusive (except at very small scales) anywhere in the world, even within the Economic Exclusive Zones of most developed countries. They are conspicuously absent from the high seas, and radical reform of the RFMOs responsible for such management as does exist is long overdue.

Given the continuing deterioration in the conservation status of seabirds, and the increased number and severity of threats confronting them, there is an urgent need to identify and implement practical action to tackle threats to species and sites where feasibility and priority coincide. As seabirds are amongst the best indicators of the status of marine systems, the outlook for the global oceans is not encouraging. However, progress in addressing pollution (Roser, 2018), invasive alien species (Jones et al., 2016) and bycatch (Maree et al., 2014) shows what can be done; effective management of threats in key areas on land and at sea is now the great challenge.

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855 # Tables

856

857 Table 1: System for scoring impact of threats (from Garnett et al., 2018). Values within parentheses
858 represent the percentage of the total population affected (scope) and the known or likely rate of
859 population decline caused by the threat over three generations (severity). Impact values are the
860 average of the product of the extremes of scope and severity in each interval
861 (mean[min(scope)*min(severity)/100, max(scope)*max(severity)/100])

Scope/Severity	Very Rapid Declines (>30%)	Rapid Declines [20-30%]	Slow but Significant Declines or Causing/Could cause fluctuations [5-20%[	Negligible Declines (<5%)
	63	23.5	11.8	2.9
Whole (>90%)	Very high	High	Medium	Low
	51.6	17.9	9.7	2.4
Majority [50-90%]	Very high	High	Medium	Low
	24.9	7.4	4.8	1.2
Minority (<50%)	High	Medium	Medium	Low

862

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Table 2: Summary of the top threats (impacting more than 20% of the species or having an high overall impact) affecting: all seabird species; only globally threatened species; only Near Threatened (NT) species and Least Concern (LC) species with declining trends. N species: number of species affected; N species main threat: number of species for which the threat is the main cause of decline (i.e. highest impact); Mean impact (± SE): mean impact on the species affected by the threat; Overall impact: sum of the impact scores across all species. Threats are listed in descending order of the overall impact on all species.

	All species (n=359)				Globally threatened species (n=110)			NT and LC species (declining) (n=119)		
Threats	**N species**	**N species main threat[1]**	**Mean impact**	**Overall impact**	**N species**	**Mean impact**	**Overall impact**	**N species**	**Mean impact**	**Overall impact**
Invasive alien species	165	107	8.6 ± 0.8	1419.29	73	12.14 ± 1.64	885.89	62	6.12 ± 0.61	379.36
Bycatch	100	70	9.05 ± 0.97	904.66	50	11.78 ± 1.77	589.00	36	6.68 ± 0.75	240.62
Climate change/severe weather	96	63	8.07 ± 0.47	774.92	37	9.88 ± 0.80	365.53	43	7.44 ± 0.67	319.89
Overfishing	54	24[2]	8.49 ± 1.25	458.25	22	11.89 ± 2.81	261.49	19	6.79 ± 0.83	129.09
Hunting/trapping	97	38	4.05 ± 0.6	392.71	27	6.05 ± 1.98	163.37	35	4.03 ± 0.50	141.18
Disturbance	73	25	3.40 ± 0.36	248.31	26	4.23 ± 0.63	110.09	28	3.37 ± 0.57	94.36

[1] – Some species can have more than one threat as the main cause of decline; 2 – Excluding species for which overfishing and bycatch are both indicated as the major threat

870 Table 3: Seabird groups affected by both terrestrial and marine threats (excluding the ones related
871 to the climate change; see methods) with medium, high or very high impact*, and most frequent
872 interactions (only shown are those affecting >2 species).

Group	N species with terrestrial and marine threats	Most frequent interactions terrestrial - marine	Number of species affected
Albatrosses	13 (59%)	Invasive alien species - Bycatch	10
		Diseases - Bycatch	3
Penguins	9 (50%)	Problematic native species - Pollution	4
		Invasive alien species - Pollution	3
		Problematic native species - Overfishing	3
		Hunting/trapping - Pollution	3
Auks	11 (46%)	Invasive alien species - Pollution	6
		Invasive alien species - Bycatch	3
		Disturbance - Pollution	3
Large petrels and shearwaters	13 (34%)	Invasive alien species - Bycatch	8
		Invasive alien species - Overfishing	3
Sea ducks and allies	10 (33%)	Hunting/trapping - Pollution	7
		Hunting/trapping - Bycatch	4
		Invasive alien species - Bycatch	3
Cormorants and pelicans	6 (18%)	Problematic native species - Overfishing	3

873 * only included groups with at least five species with at least one terrestrial and one marine threat

Figures

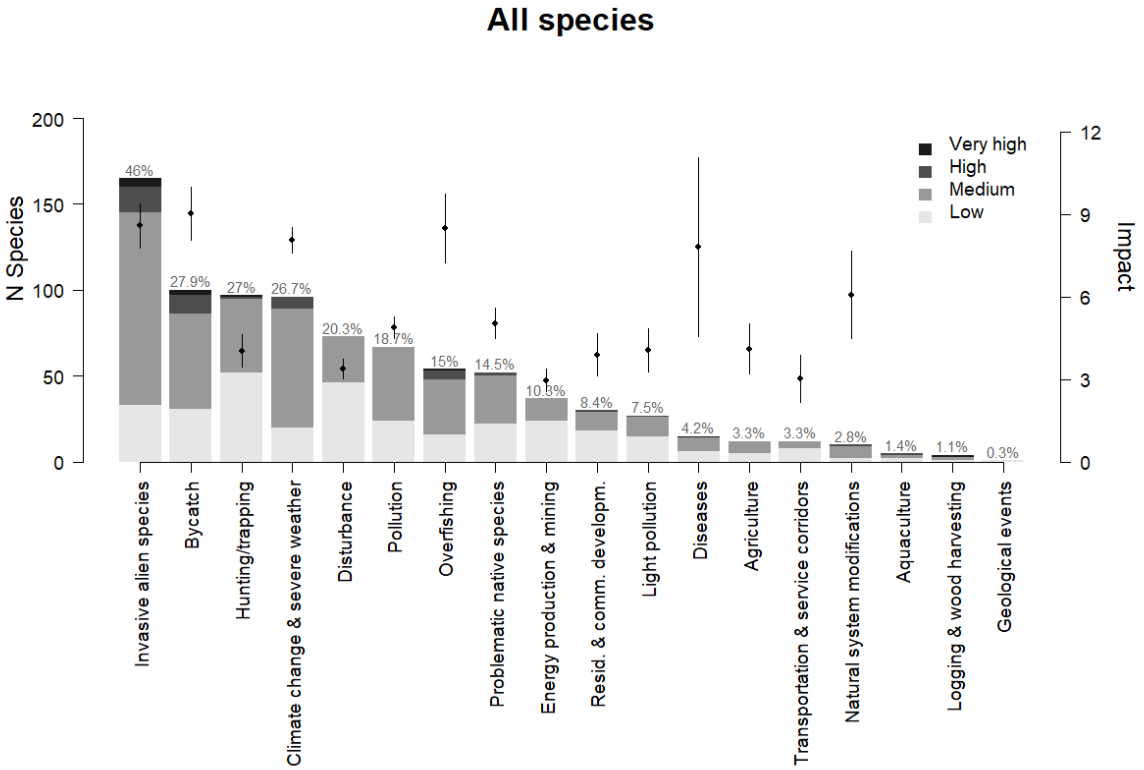

Figure 1: Ongoing threats to all seabird species (ordered by the number of species affected). Left y axis: total number of species affected; Right y axis: average impact ± SE. Values atop bars indicate the percentage of species affected (n=359).

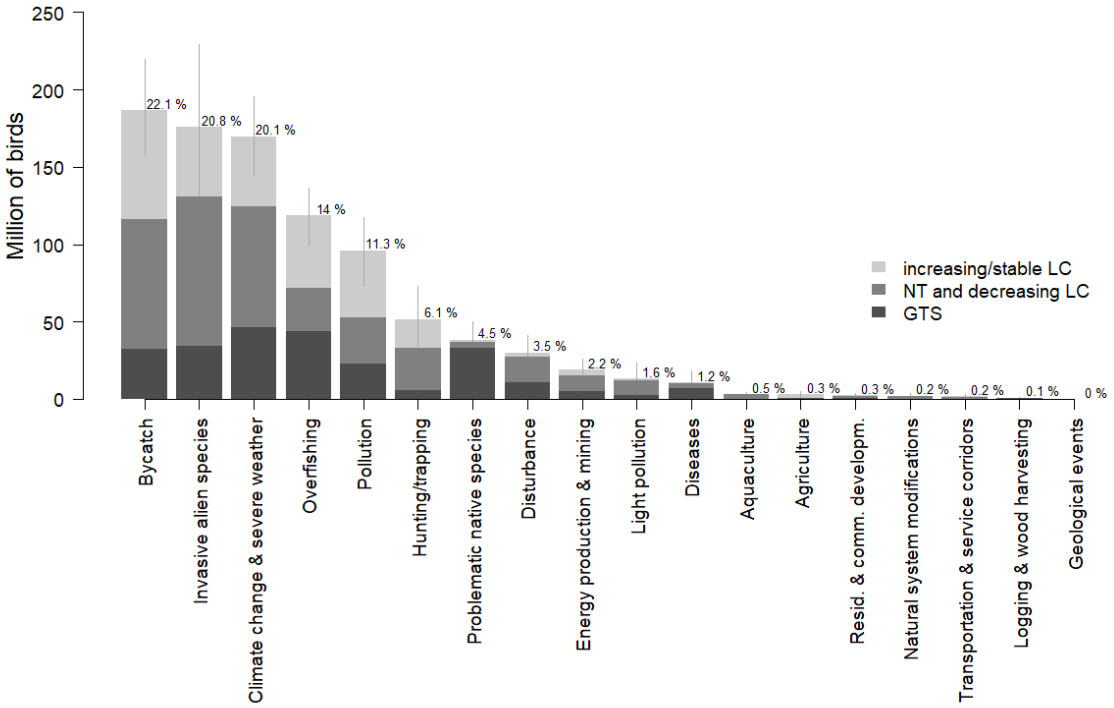

Figure 2: Estimated total number of seabirds exposed to each threat. Error bars represent the 95% confidence intervals (see methods). Values atop bars indicate percentage of total number of seabirds affected.

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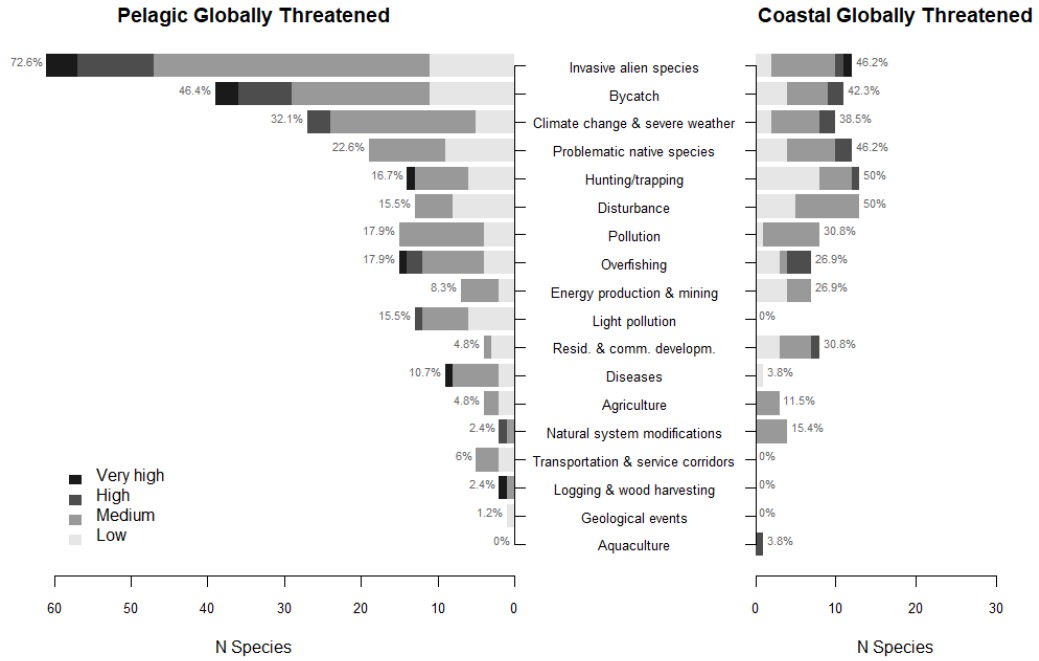

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890 Figure 3: Ongoing threats to pelagic (n=84) and coastal (n=26) globally threatened seabirds; values
891 atop bars indicate percentage of species affected.

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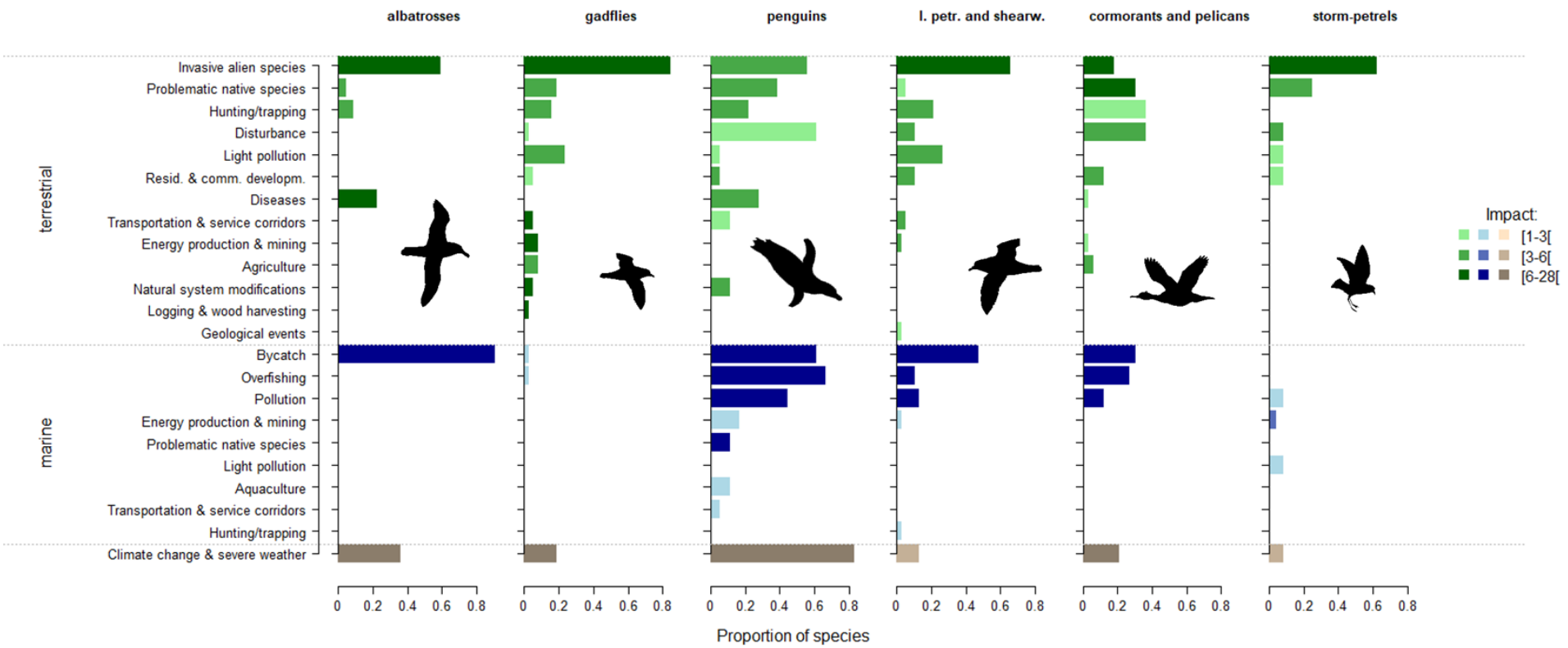
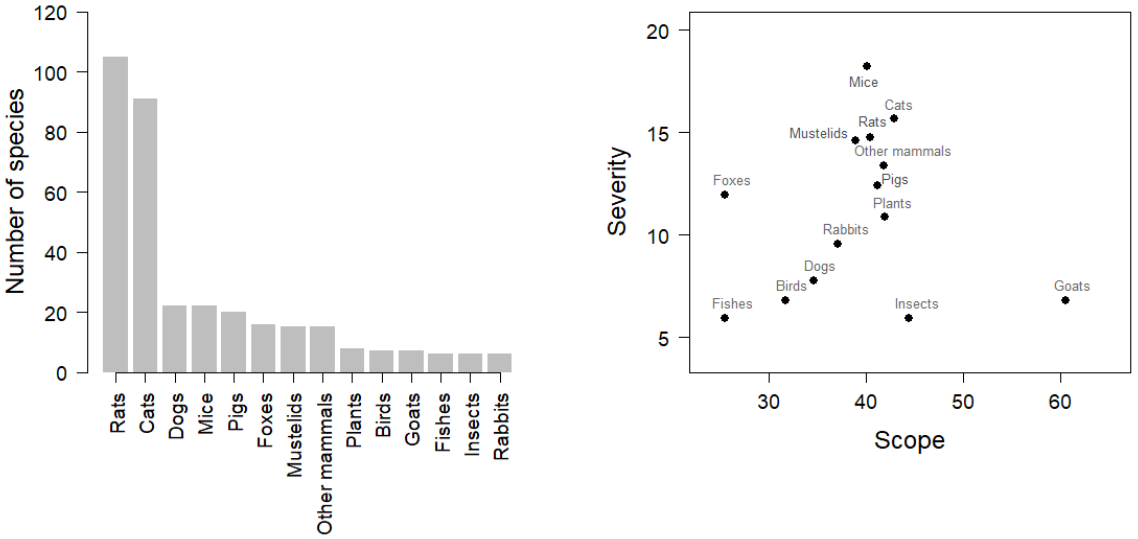


Figure 4: Main threats (split into marine and terrestrial) by group of seabird species (only groups with more than 30% of species classified as globally threatened are shown; see also Figure A4 in Appendix 3). In column headings, *l. petr. and shearw*. = large petrels and shearwaters.



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899 Figure 5: Left panel: number of seabird species affected by different invasive alien species. Right
900 panel: mean scope and severity of different invasive alien species. Only invasive alien species
901 affecting more than 5 seabird species are represented.

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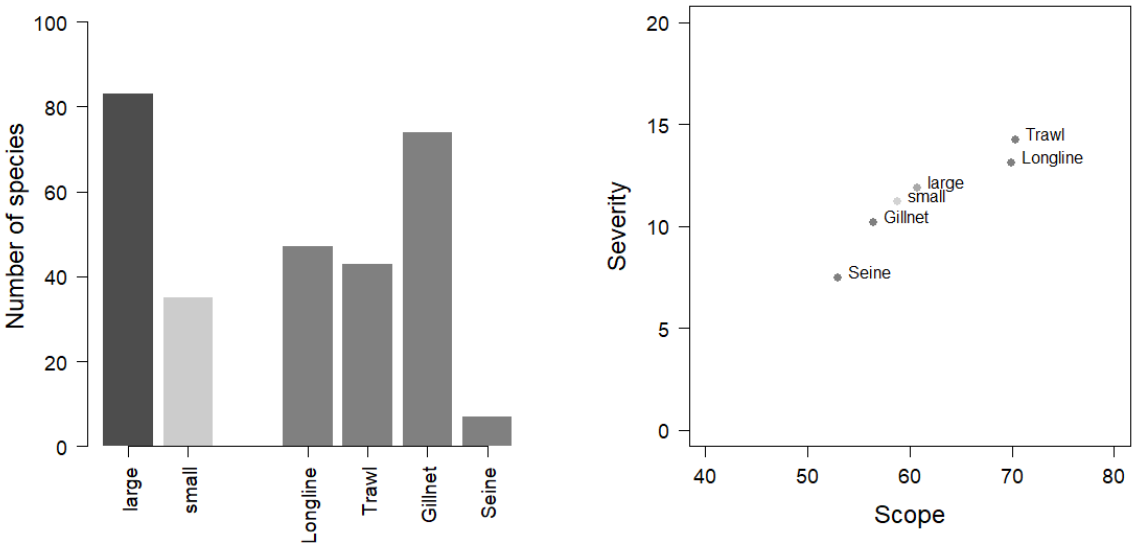

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904 Figure 6: Left panel: Number of seabird species affected by fisheries (large vs small and different
905 gear types). Right panel: mean scope and severity of large- and small-scale fisheries and of different
906 fishing gear types.

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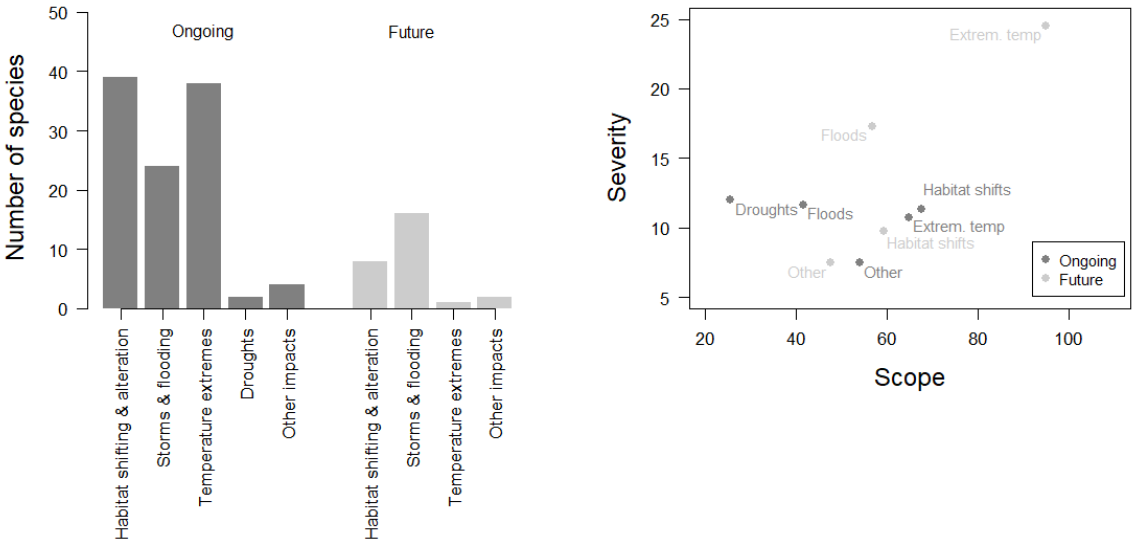

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909 Figure 7: Left panel: Number of seabird species affected by different “level-2 threats” coded for the
910 threat “climate change/severe weather” (see Table A2.2, Appendix 2). Right panel: mean scope and
911 severity of level 2 threats classified under climate change/severe weather.

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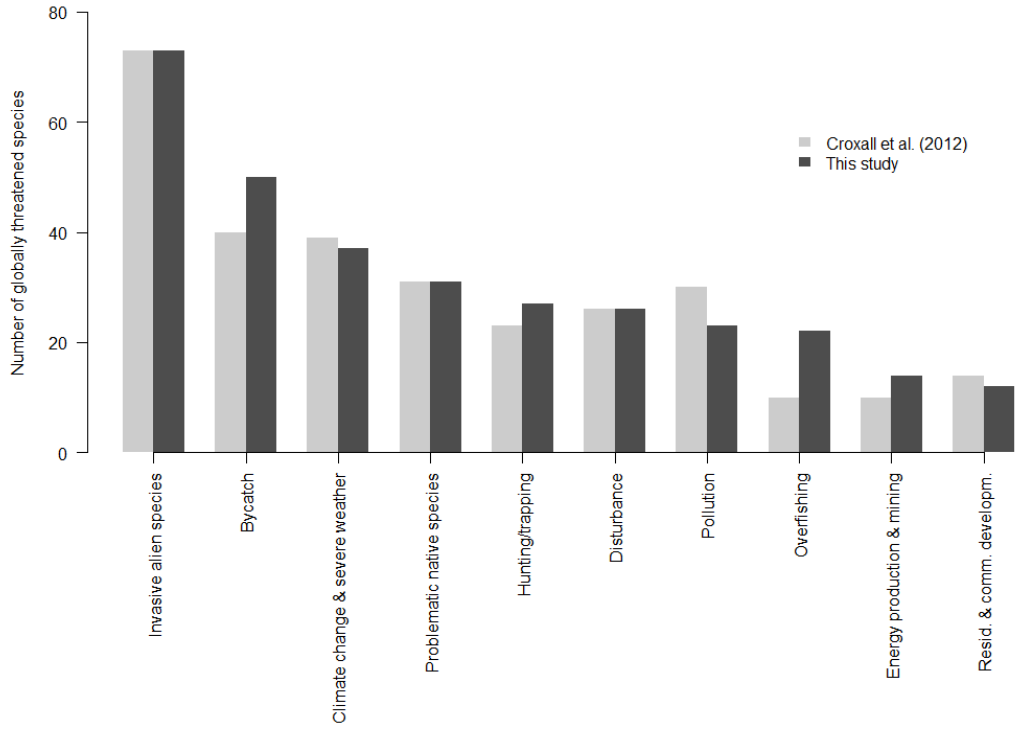

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914 Figure 8: Comparison between the number of globally threatened seabird species affected by each
915 threat as reported by Croxall et al. (2012) and found in this study. Only threats mentioned in both
916 studies are shown.

917

Appendix 1: List of seabird species considered in the analysis

The list follows the taxonomy adopted by BirdLife International (2018). 2018 IUCN Red List Category: LC = Least Concern, NT = Near Threatened, VU = Vulnerable, EN = Endangered, CR = Critically Endangered, CR(PE) = Critically Endangered (Possibly Extinct), DD = Data Deficient. The classification into Coastal and Pelagic is based on Croxall et al. (2012)

Order	Family	Scientific name	Common name	2018 IUCN Red List Category	Pelagic / coastal	Group
Anseriformes	Anatidae	*Aythya marila*	Greater Scaup	LC	Coastal	sea ducks and allies
Anseriformes	Anatidae	*Bucephala clangula*	Common Goldeneye	LC	Coastal	sea ducks and allies
Anseriformes	Anatidae	*Bucephala islandica*	Barrow's Goldeneye	LC	Coastal	sea ducks and allies
Anseriformes	Anatidae	*Clangula hyemalis*	Long-tailed Duck	VU	Coastal	sea ducks and allies
Anseriformes	Anatidae	*Histrionicus histrionicus*	Harlequin Duck	LC	Coastal	sea ducks and allies
Anseriformes	Anatidae	*Melanitta americana*	Black Scoter	NT	Coastal	sea ducks and allies
Anseriformes	Anatidae	*Melanitta deglandi*	White-winged Scoter	LC	Coastal	sea ducks and allies
Anseriformes	Anatidae	*Melanitta fusca*	Velvet Scoter	VU	Coastal	sea ducks and allies
Anseriformes	Anatidae	*Melanitta nigra*	Common Scoter	LC	Coastal	sea ducks and allies
Anseriformes	Anatidae	*Melanitta perspicillata*	Surf Scoter	LC	Coastal	sea ducks and allies
Anseriformes	Anatidae	*Melanitta stejnegeri*	Siberian Scoter	LC	Coastal	sea ducks and allies
Anseriformes	Anatidae	*Mergus merganser*	Goosander	LC	Coastal	sea ducks and allies
Anseriformes	Anatidae	*Mergus serrator*	Red-breasted Merganser	LC	Coastal	sea ducks and allies
Anseriformes	Anatidae	*Polysticta stelleri*	Steller's Eider	VU	Coastal	sea ducks and allies
Anseriformes	Anatidae	*Somateria fischeri*	Spectacled Eider	NT	Coastal	sea ducks and allies
Anseriformes	Anatidae	*Somateria mollissima*	Common Eider	NT	Coastal	sea ducks and allies
Anseriformes	Anatidae	*Somateria spectabilis*	King Eider	LC	Coastal	sea ducks and allies
Anseriformes	Anatidae	*Tachyeres brachypterus*	Falkland Steamerduck	LC	Coastal	sea ducks and allies
Anseriformes	Anatidae	*Tachyeres leucocephalus*	White-headed Steamerduck	VU	Coastal	sea ducks and allies
Anseriformes	Anatidae	*Tachyeres patachonicus*	Flying Steamerduck	LC	Coastal	sea ducks and allies
Anseriformes	Anatidae	*Tachyeres pteneres*	Magellanic Steamerduck	LC	Coastal	sea ducks and allies

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Charadriiformes	Alcidae	*Aethia cristatella*	Crested Auklet	LC	Pelagic	auks
Charadriiformes	Alcidae	*Aethia psittacula*	Parakeet Auklet	LC	Pelagic	auks
Charadriiformes	Alcidae	*Aethia pusilla*	Least Auklet	LC	Pelagic	auks
Charadriiformes	Alcidae	*Aethia pygmaea*	Whiskered Auklet	LC	Pelagic	auks
Charadriiformes	Alcidae	*Alca torda*	Razorbill	NT	Pelagic	auks
Charadriiformes	Alcidae	*Alle alle*	Little Auk	LC	Pelagic	auks
Charadriiformes	Alcidae	*Brachyramphus brevirostris*	Kittlitz's Murrelet	NT	Pelagic	auks
Charadriiformes	Alcidae	*Brachyramphus marmoratus*	Marbled Murrelet	EN	Pelagic	auks
Charadriiformes	Alcidae	*Brachyramphus perdix*	Long-billed Murrelet	NT	Pelagic	auks
Charadriiformes	Alcidae	*Cepphus carbo*	Spectacled Guillemot	LC	Pelagic	auks
Charadriiformes	Alcidae	*Cepphus columba*	Pigeon Guillemot	LC	Pelagic	auks
Charadriiformes	Alcidae	*Cepphus grylle*	Black Guillemot	LC	Pelagic	auks
Charadriiformes	Alcidae	*Cerorhinca monocerata*	Rhinoceros Auklet	LC	Pelagic	auks
Charadriiformes	Alcidae	*Fratercula arctica*	Atlantic Puffin	VU	Pelagic	auks
Charadriiformes	Alcidae	*Fratercula cirrhata*	Tufted Puffin	LC	Pelagic	auks
Charadriiformes	Alcidae	*Fratercula corniculata*	Horned Puffin	LC	Pelagic	auks
Charadriiformes	Alcidae	*Ptychoramphus aleuticus*	Cassin's Auklet	NT	Pelagic	auks
Charadriiformes	Alcidae	*Synthliboramphus antiquus*	Ancient Murrelet	LC	Pelagic	auks
Charadriiformes	Alcidae	*Synthliboramphus craveri*	Craveri's Murrelet	VU	Pelagic	auks
Charadriiformes	Alcidae	*Synthliboramphus hypoleucus*	Guadalupe Murrelet	EN	Pelagic	auks
Charadriiformes	Alcidae	*Synthliboramphus scrippsi*	Scripps's Murrelet	VU	Pelagic	auks
Charadriiformes	Alcidae	*Synthliboramphus wumizusume*	Japanese Murrelet	VU	Pelagic	auks
Charadriiformes	Alcidae	*Uria aalge*	Common Murre	LC	Pelagic	auks
Charadriiformes	Alcidae	*Uria lomvia*	Thick-billed Murre	LC	Pelagic	auks
Charadriiformes	Laridae	*Creagrus furcatus*	Swallow-tailed Gull	LC	Coastal	gulls
Charadriiformes	Laridae	*Hydrocoloeus minutus*	Little Gull	LC	Coastal	gulls
Charadriiformes	Laridae	*Larus argentatus*	European Herring Gull	LC	Coastal	gulls
Charadriiformes	Laridae	*Larus atlanticus*	Olrog's Gull	NT	Coastal	gulls

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Charadriiformes	Laridae	*Larus atricilla*	Laughing Gull	LC	Coastal	gulls
Charadriiformes	Laridae	*Larus audouinii*	Audouin's Gull	LC	Coastal	gulls
Charadriiformes	Laridae	*Larus belcheri*	Belcher's Gull	LC	Coastal	gulls
Charadriiformes	Laridae	*Larus brunnicephalus*	Brown-headed Gull	LC	Coastal	gulls
Charadriiformes	Laridae	*Larus cachinnans*	Caspian Gull	LC	Coastal	gulls
Charadriiformes	Laridae	*Larus californicus*	California Gull	LC	Coastal	gulls
Charadriiformes	Laridae	*Larus canus*	Mew Gull	LC	Coastal	gulls
Charadriiformes	Laridae	*Larus cirrocephalus*	Grey-headed Gull	LC	Coastal	gulls
Charadriiformes	Laridae	*Larus crassirostris*	Black-tailed Gull	LC	Coastal	gulls
Charadriiformes	Laridae	*Larus delawarensis*	Ring-billed Gull	LC	Coastal	gulls
Charadriiformes	Laridae	*Larus dominicanus*	Kelp Gull	LC	Coastal	gulls
Charadriiformes	Laridae	*Larus fuliginosus*	Lava Gull	VU	Coastal	gulls
Charadriiformes	Laridae	*Larus fuscus*	Lesser Black-backed Gull	LC	Coastal	gulls
Charadriiformes	Laridae	*Larus genei*	Slender-billed Gull	LC	Coastal	gulls
Charadriiformes	Laridae	*Larus glaucescens*	Glaucous-winged Gull	LC	Coastal	gulls
Charadriiformes	Laridae	*Larus glaucoides*	Iceland Gull	LC	Coastal	gulls
Charadriiformes	Laridae	*Larus hartlaubii*	Hartlaub's Gull	LC	Coastal	gulls
Charadriiformes	Laridae	*Larus heermanni*	Heermann's Gull	NT	Coastal	gulls
Charadriiformes	Laridae	*Larus hemprichii*	Sooty Gull	LC	Coastal	gulls
Charadriiformes	Laridae	*Larus hyperboreus*	Glaucous Gull	LC	Coastal	gulls
Charadriiformes	Laridae	*Larus ichthyaetus*	Pallas's Gull	LC	Coastal	gulls
Charadriiformes	Laridae	*Larus leucophthalmus*	White-eyed Gull	LC	Coastal	gulls
Charadriiformes	Laridae	*Larus livens*	Yellow-footed Gull	LC	Coastal	gulls
Charadriiformes	Laridae	*Larus maculipennis*	Brown-hooded Gull	LC	Coastal	gulls
Charadriiformes	Laridae	*Larus marinus*	Great Black-backed Gull	LC	Coastal	gulls
Charadriiformes	Laridae	*Larus melanocephalus*	Mediterranean Gull	LC	Coastal	gulls
Charadriiformes	Laridae	*Larus michahellis*	Yellow-legged Gull	LC	Coastal	gulls
Charadriiformes	Laridae	*Larus modestus*	Grey Gull	LC	Coastal	gulls

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Charadriiformes	Laridae	*Larus novaehollandiae*	Silver Gull	LC	Coastal	gulls
Charadriiformes	Laridae	*Larus occidentalis*	Western Gull	LC	Coastal	gulls
Charadriiformes	Laridae	*Larus pacificus*	Pacific Gull	LC	Coastal	gulls
Charadriiformes	Laridae	*Larus philadelphia*	Bonaparte's Gull	LC	Coastal	gulls
Charadriiformes	Laridae	*Larus pipixcan*	Franklin's Gull	LC	Coastal	gulls
Charadriiformes	Laridae	*Larus ridibundus*	Black-headed Gull	LC	Coastal	gulls
Charadriiformes	Laridae	*Larus schistisagus*	Slaty-backed Gull	LC	Coastal	gulls
Charadriiformes	Laridae	*Larus scoresbii*	Dolphin Gull	LC	Coastal	gulls
Charadriiformes	Laridae	*Larus smithsonianus*	Arctic Herring Gull	LC	Coastal	gulls
Charadriiformes	Laridae	*Pagophila eburnea*	Ivory Gull	NT	Coastal	gulls
Charadriiformes	Laridae	*Rhodostethia rosea*	Ross's Gull	LC	Coastal	gulls
Charadriiformes	Laridae	*Rissa brevirostris*	Red-legged Kittiwake	VU	Coastal	gulls
Charadriiformes	Laridae	*Rissa tridactyla*	Black-legged Kittiwake	VU	Coastal	gulls
Charadriiformes	Laridae	*Saundersilarus saundersi*	Saunders's Gull	VU	Coastal	gulls
Charadriiformes	Laridae	*Xema sabini*	Sabine's Gull	LC	Coastal	gulls
Charadriiformes	Scolopacidae	*Phalaropus fulicarius*	Red Phalarope	LC	Coastal	phalaropes
Charadriiformes	Scolopacidae	*Phalaropus lobatus*	Red-necked Phalarope	LC	Coastal	phalaropes
Charadriiformes	Stercorariidae	*Catharacta antarctica*	Brown Skua	LC	Pelagic	skuas
Charadriiformes	Stercorariidae	*Catharacta chilensis*	Chilean Skua	LC	Pelagic	skuas
Charadriiformes	Stercorariidae	*Catharacta maccormicki*	South Polar Skua	LC	Pelagic	skuas
Charadriiformes	Stercorariidae	*Catharacta skua*	Great Skua	LC	Pelagic	skuas
Charadriiformes	Stercorariidae	*Stercorarius longicaudus*	Long-tailed Jaeger	LC	Pelagic	skuas
Charadriiformes	Stercorariidae	*Stercorarius parasiticus*	Arctic Jaeger	LC	Pelagic	skuas
Charadriiformes	Stercorariidae	*Stercorarius pomarinus*	Pomarine Jaeger	LC	Pelagic	skuas
Charadriiformes	Laridae	*Anous minutus*	Black Noddy	LC	Coastal	terns
Charadriiformes	Laridae	*Anous stolidus*	Brown Noddy	LC	Coastal	terns
Charadriiformes	Laridae	*Anous tenuirostris*	Lesser Noddy	LC	Coastal	terns
Charadriiformes	Laridae	*Chlidonias albostriatus*	Black-fronted Tern	EN	Coastal	terns

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Charadriiformes	Laridae	*Chlidonias niger*	Black Tern	LC	Coastal	terns
Charadriiformes	Laridae	*Gelochelidon macrotarsa*	Australian Gull-billed Tern	LC	Coastal	terns
Charadriiformes	Laridae	*Gelochelidon nilotica*	Common Gull-billed Tern	LC	Coastal	terns
Charadriiformes	Laridae	*Gygis alba*	Common White Tern	LC	Coastal	terns
Charadriiformes	Laridae	*Gygis microrhyncha*	Little White Tern	LC	Coastal	terns
Charadriiformes	Laridae	*Hydroprogne caspia*	Caspian Tern	LC	Coastal	terns
Charadriiformes	Laridae	*Larosterna inca*	Inca Tern	NT	Coastal	terns
Charadriiformes	Laridae	*Onychoprion aleuticus*	Aleutian Tern	VU	Coastal	terns
Charadriiformes	Laridae	*Onychoprion anaethetus*	Bridled Tern	LC	Coastal	terns
Charadriiformes	Laridae	*Onychoprion fuscatus*	Sooty Tern	LC	Coastal	terns
Charadriiformes	Laridae	*Onychoprion lunatus*	Grey-backed Tern	LC	Coastal	terns
Charadriiformes	Laridae	*Anous albivitta*	Grey Noddy	LC	Coastal	terns
Charadriiformes	Laridae	*Anous cerulea*	Blue Noddy	LC	Coastal	terns
Charadriiformes	Laridae	*Sterna dougallii*	Roseate Tern	LC	Coastal	terns
Charadriiformes	Laridae	*Sterna forsteri*	Forster's Tern	LC	Coastal	terns
Charadriiformes	Laridae	*Sterna hirundinacea*	South American Tern	LC	Coastal	terns
Charadriiformes	Laridae	*Sterna hirundo*	Common Tern	LC	Coastal	terns
Charadriiformes	Laridae	*Sterna paradisaea*	Arctic Tern	LC	Coastal	terns
Charadriiformes	Laridae	*Sterna repressa*	White-cheeked Tern	LC	Coastal	terns
Charadriiformes	Laridae	*Sterna striata*	White-fronted Tern	NT	Coastal	terns
Charadriiformes	Laridae	*Sterna sumatrana*	Black-naped Tern	LC	Coastal	terns
Charadriiformes	Laridae	*Sterna trudeaui*	Snowy-crowned Tern	LC	Coastal	terns
Charadriiformes	Laridae	*Sterna virgata*	Kerguelen Tern	NT	Coastal	terns
Charadriiformes	Laridae	*Sterna vittata*	Antarctic Tern	LC	Coastal	terns
Charadriiformes	Laridae	*Sternula albifrons*	Little Tern	LC	Coastal	terns
Charadriiformes	Laridae	*Sternula antillarum*	Least Tern	LC	Coastal	terns
Charadriiformes	Laridae	*Sternula balaenarum*	Damara Tern	VU	Coastal	terns
Charadriiformes	Laridae	*Sternula lorata*	Peruvian Tern	EN	Coastal	terns

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Charadriiformes	Laridae	*Sternula nereis*	Fairy Tern	VU	Coastal	terns
Charadriiformes	Laridae	*Sternula saundersi*	Saunders's Tern	LC	Coastal	terns
Charadriiformes	Laridae	*Thalasseus bengalensis*	Lesser Crested Tern	LC	Coastal	terns
Charadriiformes	Laridae	*Thalasseus bergii*	Greater Crested Tern	LC	Coastal	terns
Charadriiformes	Laridae	*Thalasseus bernsteini*	Chinese Crested Tern	CR	Coastal	terns
Charadriiformes	Laridae	*Thalasseus elegans*	Elegant Tern	NT	Coastal	terns
Charadriiformes	Laridae	*Thalasseus maximus*	Royal Tern	LC	Coastal	terns
Charadriiformes	Laridae	*Thalasseus sandvicensis*	Sandwich Tern	LC	Coastal	terns
Gaviiformes	Gaviidae	*Gavia adamsii*	Yellow-billed Loon	NT	Coastal	sea ducks and allies
Gaviiformes	Gaviidae	*Gavia arctica*	Arctic Loon	LC	Coastal	sea ducks and allies
Gaviiformes	Gaviidae	*Gavia immer*	Common Loon	LC	Coastal	sea ducks and allies
Gaviiformes	Gaviidae	*Gavia pacifica*	Pacific Loon	LC	Coastal	sea ducks and allies
Gaviiformes	Gaviidae	*Gavia stellata*	Red-throated Loon	LC	Coastal	sea ducks and allies
Pelecaniformes	Pelecanidae	*Pelecanus occidentalis*	Brown Pelican	LC	Coastal	cormorants and pelicans
Pelecaniformes	Pelecanidae	*Pelecanus onocrotalus*	Great White Pelican	LC	Coastal	cormorants and pelicans
Pelecaniformes	Pelecanidae	*Pelecanus thagus*	Peruvian Pelican	NT	Pelagic	cormorants and pelicans
Phaethontiformes	Phaethontidae	*Phaethon aethereus*	Red-billed Tropicbird	LC	Pelagic	frigatebirds and tropicbirds
Phaethontiformes	Phaethontidae	*Phaethon lepturus*	White-tailed Tropicbird	LC	Pelagic	frigatebirds and tropicbirds
Phaethontiformes	Phaethontidae	*Phaethon rubricauda*	Red-tailed Tropicbird	LC	Pelagic	frigatebirds and tropicbirds
Podicipediformes	Podicipedidae	*Podiceps auritus*	Horned Grebe	VU	Coastal	sea ducks and allies
Podicipediformes	Podicipedidae	*Podiceps cristatus*	Great Crested Grebe	LC	Coastal	sea ducks and allies
Podicipediformes	Podicipedidae	*Podiceps grisegena*	Red-necked Grebe	LC	Coastal	sea ducks and allies
Podicipediformes	Podicipedidae	*Podiceps nigricollis*	Black-necked Grebe	LC	Coastal	sea ducks and allies
Procellariiformes	Diomedeidae	*Diomedea amsterdamensis*	Amsterdam Albatross	EN	Pelagic	albatrosses
Procellariiformes	Diomedeidae	*Diomedea antipodensis*	Antipodean Albatross	EN	Pelagic	albatrosses
Procellariiformes	Diomedeidae	*Diomedea dabbenena*	Tristan Albatross	CR	Pelagic	albatrosses
Procellariiformes	Diomedeidae	*Diomedea epomophora*	Southern Royal Albatross	VU	Pelagic	albatrosses
Procellariiformes	Diomedeidae	*Diomedea exulans*	Wandering Albatross	VU	Pelagic	albatrosses

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Procellariiformes	Diomedeidae	*Diomedea sanfordi*	Northern Royal Albatross	EN	Pelagic	albatrosses
Procellariiformes	Diomedeidae	*Phoebastria albatrus*	Short-tailed Albatross	VU	Pelagic	albatrosses
Procellariiformes	Diomedeidae	*Phoebastria immutabilis*	Laysan Albatross	NT	Pelagic	albatrosses
Procellariiformes	Diomedeidae	*Phoebastria irrorata*	Waved Albatross	CR	Pelagic	albatrosses
Procellariiformes	Diomedeidae	*Phoebastria nigripes*	Black-footed Albatross	NT	Pelagic	albatrosses
Procellariiformes	Diomedeidae	*Phoebetria fusca*	Sooty Albatross	EN	Pelagic	albatrosses
Procellariiformes	Diomedeidae	*Phoebetria palpebrata*	Light-mantled Albatross	NT	Pelagic	albatrosses
Procellariiformes	Diomedeidae	*Thalassarche bulleri*	Buller's Albatross	NT	Pelagic	albatrosses
Procellariiformes	Diomedeidae	*Thalassarche carteri*	Indian Yellow-nosed Albatross	EN	Pelagic	albatrosses
Procellariiformes	Diomedeidae	*Thalassarche cauta*	Shy Albatross	NT	Pelagic	albatrosses
Procellariiformes	Diomedeidae	*Thalassarche chlororhynchos*	Atlantic Yellow-nosed Albatross	EN	Pelagic	albatrosses
Procellariiformes	Diomedeidae	*Thalassarche chrysostoma*	Grey-headed Albatross	EN	Pelagic	albatrosses
Procellariiformes	Diomedeidae	*Thalassarche eremita*	Chatham Albatross	VU	Pelagic	albatrosses
Procellariiformes	Diomedeidae	*Thalassarche impavida*	Campbell Albatross	VU	Pelagic	albatrosses
Procellariiformes	Diomedeidae	*Thalassarche melanophris*	Black-browed Albatross	LC	Pelagic	albatrosses
Procellariiformes	Diomedeidae	*Thalassarche salvini*	Salvin's Albatross	VU	Pelagic	albatrosses
Procellariiformes	Diomedeidae	*Thalassarche steadi*	White-capped Albatross	NT	Pelagic	albatrosses
Procellariiformes	Procellariidae	*Pseudobulweria aterrima*	Mascarene Petrel	CR	Pelagic	gadflies
Procellariiformes	Procellariidae	*Pseudobulweria becki*	Beck's Petrel	CR	Pelagic	gadflies
Procellariiformes	Procellariidae	*Pseudobulweria macgillivrayi*	Fiji Petrel	CR	Pelagic	gadflies
Procellariiformes	Procellariidae	*Pseudobulweria rostrata*	Tahiti Petrel	NT	Pelagic	gadflies
Procellariiformes	Procellariidae	*Pterodroma alba*	Phoenix Petrel	EN	Pelagic	gadflies
Procellariiformes	Procellariidae	*Pterodroma arminjoniana*	Trindade Petrel	VU	Pelagic	gadflies
Procellariiformes	Procellariidae	*Pterodroma atrata*	Henderson Petrel	EN	Pelagic	gadflies
Procellariiformes	Procellariidae	*Pterodroma axillaris*	Chatham Petrel	VU	Pelagic	gadflies
Procellariiformes	Procellariidae	*Pterodroma baraui*	Barau's Petrel	EN	Pelagic	gadflies
Procellariiformes	Procellariidae	*Pterodroma brevipes*	Collared Petrel	VU	Pelagic	gadflies
Procellariiformes	Procellariidae	*Pterodroma cahow*	Bermuda Petrel	EN	Pelagic	gadflies

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Procellariiformes	Procellariidae	*Pterodroma caribbaea*	Jamaican Petrel	CR(PE)	Pelagic	gadflies
Procellariiformes	Procellariidae	*Pterodroma cervicalis*	White-necked Petrel	VU	Pelagic	gadflies
Procellariiformes	Procellariidae	*Pterodroma cookii*	Cook's Petrel	VU	Pelagic	gadflies
Procellariiformes	Procellariidae	*Pterodroma defilippiana*	Masatierra Petrel	VU	Pelagic	gadflies
Procellariiformes	Procellariidae	*Pterodroma deserta*	Desertas Petrel	VU	Pelagic	gadflies
Procellariiformes	Procellariidae	*Pterodroma externa*	Juan Fernandez Petrel	VU	Pelagic	gadflies
Procellariiformes	Procellariidae	*Pterodroma feae*	Cape Verde Petrel	NT	Pelagic	gadflies
Procellariiformes	Procellariidae	*Pterodroma gouldi*	Grey-faced Petrel	LC	Pelagic	gadflies
Procellariiformes	Procellariidae	*Pterodroma hasitata*	Black-capped Petrel	EN	Pelagic	gadflies
Procellariiformes	Procellariidae	*Pterodroma heraldica*	Herald Petrel	LC	Pelagic	gadflies
Procellariiformes	Procellariidae	*Pterodroma hypoleuca*	Bonin Petrel	LC	Pelagic	gadflies
Procellariiformes	Procellariidae	*Pterodroma incerta*	Atlantic Petrel	EN	Pelagic	gadflies
Procellariiformes	Procellariidae	*Pterodroma inexpectata*	Mottled Petrel	NT	Pelagic	gadflies
Procellariiformes	Procellariidae	*Pterodroma lessonii*	White-headed Petrel	LC	Pelagic	gadflies
Procellariiformes	Procellariidae	*Pterodroma leucoptera*	White-winged Petrel	VU	Pelagic	gadflies
Procellariiformes	Procellariidae	*Pterodroma longirostris*	Stejneger's Petrel	VU	Pelagic	gadflies
Procellariiformes	Procellariidae	*Pterodroma macroptera*	Great-winged Petrel	LC	Pelagic	gadflies
Procellariiformes	Procellariidae	*Pterodroma madeira*	Zino's Petrel	EN	Pelagic	gadflies
Procellariiformes	Procellariidae	*Pterodroma magentae*	Magenta Petrel	CR	Pelagic	gadflies
Procellariiformes	Procellariidae	*Pterodroma mollis*	Soft-plumaged Petrel	LC	Pelagic	gadflies
Procellariiformes	Procellariidae	*Pterodroma neglecta*	Kermadec Petrel	LC	Pelagic	gadflies
Procellariiformes	Procellariidae	*Pterodroma nigripennis*	Black-winged Petrel	LC	Pelagic	gadflies
Procellariiformes	Procellariidae	*Pterodroma phaeopygia*	Galapagos Petrel	CR	Pelagic	gadflies
Procellariiformes	Procellariidae	*Pterodroma pycrofti*	Pycroft's Petrel	VU	Pelagic	gadflies
Procellariiformes	Procellariidae	*Pterodroma sandwichensis*	Hawaiian Petrel	EN	Pelagic	gadflies
Procellariiformes	Procellariidae	*Pterodroma solandri*	Providence Petrel	VU	Pelagic	gadflies
Procellariiformes	Procellariidae	*Pterodroma ultima*	Murphy's Petrel	NT	Pelagic	gadflies
Procellariiformes	Procellariidae	*Ardenna bulleri*	Buller's Shearwater	VU	Pelagic	large petrels and shearwaters

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Procellariiformes	Procellariidae	*Ardenna carneipes*	Flesh-footed Shearwater	NT	Pelagic	large petrels and shearwaters
Procellariiformes	Procellariidae	*Ardenna creatopus*	Pink-footed Shearwater	VU	Pelagic	large petrels and shearwaters
Procellariiformes	Procellariidae	*Ardenna gravis*	Great Shearwater	LC	Pelagic	large petrels and shearwaters
Procellariiformes	Procellariidae	*Ardenna grisea*	Sooty Shearwater	NT	Pelagic	large petrels and shearwaters
Procellariiformes	Procellariidae	*Ardenna pacifica*	Wedge-tailed Shearwater	LC	Pelagic	large petrels and shearwaters
Procellariiformes	Procellariidae	*Ardenna tenuirostris*	Short-tailed Shearwater	LC	Pelagic	large petrels and shearwaters
Procellariiformes	Procellariidae	*Calonectris borealis*	Cory's Shearwater	LC	Pelagic	large petrels and shearwaters
Procellariiformes	Procellariidae	*Calonectris diomedea*	Scopoli's Shearwater	LC	Pelagic	large petrels and shearwaters
Procellariiformes	Procellariidae	*Calonectris edwardsii*	Cape Verde Shearwater	NT	Pelagic	large petrels and shearwaters
Procellariiformes	Procellariidae	*Calonectris leucomelas*	Streaked Shearwater	NT	Pelagic	large petrels and shearwaters
Procellariiformes	Procellariidae	*Fulmarus glacialis*	Northern Fulmar	LC	Pelagic	large petrels and shearwaters
Procellariiformes	Procellariidae	*Fulmarus glacialoides*	Southern Fulmar	LC	Pelagic	large petrels and shearwaters
Procellariiformes	Procellariidae	*Macronectes giganteus*	Southern Giant Petrel	LC	Pelagic	large petrels and shearwaters
Procellariiformes	Procellariidae	*Macronectes halli*	Northern Giant Petrel	LC	Pelagic	large petrels and shearwaters
Procellariiformes	Procellariidae	*Procellaria aequinoctialis*	White-chinned Petrel	VU	Pelagic	large petrels and shearwaters
Procellariiformes	Procellariidae	*Procellaria cinerea*	Grey Petrel	NT	Pelagic	large petrels and shearwaters
Procellariiformes	Procellariidae	*Procellaria conspicillata*	Spectacled Petrel	VU	Pelagic	large petrels and shearwaters
Procellariiformes	Procellariidae	*Procellaria parkinsoni*	Black Petrel	VU	Pelagic	large petrels and shearwaters
Procellariiformes	Procellariidae	*Procellaria westlandica*	Westland Petrel	EN	Pelagic	large petrels and shearwaters
Procellariiformes	Procellariidae	*Puffinus assimilis*	Little Shearwater	LC	Pelagic	large petrels and shearwaters
Procellariiformes	Procellariidae	*Puffinus auricularis*	Townsend's Shearwater	CR	Pelagic	large petrels and shearwaters
Procellariiformes	Procellariidae	*Puffinus bailloni*	Tropical Shearwater	LC	Pelagic	large petrels and shearwaters
Procellariiformes	Procellariidae	*Puffinus bannermani*	Bannerman's Shearwater	EN	Pelagic	large petrels and shearwaters
Procellariiformes	Procellariidae	*Puffinus bryani*	Bryan's Shearwater	CR	Pelagic	large petrels and shearwaters
Procellariiformes	Procellariidae	*Puffinus elegans*	Subantarctic Shearwater	LC	Pelagic	large petrels and shearwaters
Procellariiformes	Procellariidae	*Puffinus gavia*	Fluttering Shearwater	LC	Pelagic	large petrels and shearwaters
Procellariiformes	Procellariidae	*Puffinus heinrothi*	Heinroth's Shearwater	VU	Pelagic	large petrels and shearwaters
Procellariiformes	Procellariidae	*Puffinus huttoni*	Hutton's Shearwater	EN	Pelagic	large petrels and shearwaters

Order	Family	Scientific name	Common name	2018 IUCN Red List Category	Pelagic / coastal	Group
Procellariiformes	Procellariidae	*Puffinus lherminieri*	Audubon's Shearwater	LC	Pelagic	large petrels and shearwaters
Procellariiformes	Procellariidae	*Puffinus mauretanicus*	Balearic Shearwater	CR	Pelagic	large petrels and shearwaters
Procellariiformes	Procellariidae	*Puffinus nativitatis*	Christmas Shearwater	LC	Pelagic	large petrels and shearwaters
Procellariiformes	Procellariidae	*Puffinus newelli*	Newell's Shearwater	CR	Pelagic	large petrels and shearwaters
Procellariiformes	Procellariidae	*Puffinus opisthomelas*	Black-vented Shearwater	NT	Pelagic	large petrels and shearwaters
Procellariiformes	Procellariidae	*Puffinus persicus*	Persian Shearwater	LC	Pelagic	large petrels and shearwaters
Procellariiformes	Procellariidae	*Puffinus puffinus*	Manx Shearwater	LC	Pelagic	large petrels and shearwaters
Procellariiformes	Procellariidae	*Puffinus subalaris*	Galapagos Shearwater	LC	Pelagic	large petrels and shearwaters
Procellariiformes	Procellariidae	*Puffinus yelkouan*	Yelkouan Shearwater	VU	Pelagic	large petrels and shearwaters
Procellariiformes	Procellariidae	*Aphrodroma brevirostris*	Kerguelen Petrel	LC	Pelagic	small petrels
Procellariiformes	Procellariidae	*Bulweria bulwerii*	Bulwer's Petrel	LC	Pelagic	small petrels
Procellariiformes	Procellariidae	*Bulweria fallax*	Jouanin's Petrel	NT	Pelagic	small petrels
Procellariiformes	Procellariidae	*Daption capense*	Cape Petrel	LC	Pelagic	small petrels
Procellariiformes	Procellariidae	*Halobaena caerulea*	Blue Petrel	LC	Pelagic	small petrels
Procellariiformes	Procellariidae	*Pachyptila belcheri*	Slender-billed Prion	LC	Pelagic	small petrels
Procellariiformes	Procellariidae	*Pachyptila crassirostris*	Fulmar Prion	LC	Pelagic	small petrels
Procellariiformes	Procellariidae	*Pachyptila desolata*	Antarctic Prion	LC	Pelagic	small petrels
Procellariiformes	Procellariidae	*Pachyptila macgillivrayi*	MacGillivray's Prion	EN	Pelagic	small petrels
Procellariiformes	Procellariidae	*Pachyptila salvini*	Salvin's Prion	LC	Pelagic	small petrels
Procellariiformes	Procellariidae	*Pachyptila turtur*	Fairy Prion	LC	Pelagic	small petrels
Procellariiformes	Procellariidae	*Pachyptila vittata*	Broad-billed Prion	LC	Pelagic	small petrels
Procellariiformes	Procellariidae	*Pagodroma nivea*	Snow Petrel	LC	Pelagic	small petrels
Procellariiformes	Procellariidae	*Pelecanoides garnotii*	Peruvian Diving-petrel	EN	Pelagic	small petrels
Procellariiformes	Procellariidae	*Pelecanoides georgicus*	South Georgia Diving-petrel	LC	Pelagic	small petrels
Procellariiformes	Procellariidae	*Pelecanoides magellani*	Magellanic Diving-petrel	LC	Pelagic	small petrels
Procellariiformes	Procellariidae	*Pelecanoides urinatrix*	Common Diving-petrel	LC	Pelagic	small petrels
Procellariiformes	Procellariidae	*Thalassoica antarctica*	Antarctic Petrel	LC	Pelagic	small petrels
Procellariiformes	Oceanitidae	*Fregetta grallaria*	White-bellied Storm-petrel	LC	Pelagic	storm-petrels

Order	Family	Scientific name	Common name	2018 IUCN Red List Category	Pelagic / coastal	Group
Procellariiformes	Oceanitidae	*Fregetta maoriana*	New Zealand Storm-petrel	CR	Pelagic	storm-petrels
Procellariiformes	Oceanitidae	*Fregetta tropica*	Black-bellied Storm-petrel	LC	Pelagic	storm-petrels
Procellariiformes	Oceanitidae	*Garrodia nereis*	Grey-backed Storm-petrel	LC	Pelagic	storm-petrels
Procellariiformes	Hydrobatidae	*Hydrobates castro*	Band-rumped Storm-petrel	LC	Pelagic	storm-petrels
Procellariiformes	Hydrobatidae	*Hydrobates furcatus*	Fork-tailed Storm-petrel	LC	Pelagic	storm-petrels
Procellariiformes	Hydrobatidae	*Hydrobates homochroa*	Ashy Storm-petrel	EN	Pelagic	storm-petrels
Procellariiformes	Hydrobatidae	*Hydrobates hornbyi*	Ringed Storm-petrel	DD	Pelagic	storm-petrels
Procellariiformes	Hydrobatidae	*Hydrobates leucorhous*	Leach's Storm-petrel	VU	Pelagic	storm-petrels
Procellariiformes	Hydrobatidae	*Hydrobates macrodactylus*	Guadalupe Storm-petrel	CR(PE)	Pelagic	storm-petrels
Procellariiformes	Hydrobatidae	*Hydrobates markhami*	Markham's Storm-petrel	DD	Pelagic	storm-petrels
Procellariiformes	Hydrobatidae	*Hydrobates matsudairae*	Matsudaira's Storm-petrel	VU	Pelagic	storm-petrels
Procellariiformes	Hydrobatidae	*Hydrobates melania*	Black Storm-petrel	LC	Pelagic	storm-petrels
Procellariiformes	Hydrobatidae	*Hydrobates microsoma*	Least Storm-petrel	LC	Pelagic	storm-petrels
Procellariiformes	Hydrobatidae	*Hydrobates monorhis*	Swinhoe's Storm-petrel	NT	Pelagic	storm-petrels
Procellariiformes	Hydrobatidae	*Hydrobates monteiroi*	Monteiro's Storm-petrel	VU	Pelagic	storm-petrels
Procellariiformes	Hydrobatidae	*Hydrobates pelagicus*	European Storm-petrel	LC	Pelagic	storm-petrels
Procellariiformes	Hydrobatidae	*Hydrobates tethys*	Wedge-rumped Storm-petrel	LC	Pelagic	storm-petrels
Procellariiformes	Hydrobatidae	*Hydrobates tristrami*	Tristram's Storm-petrel	NT	Pelagic	storm-petrels
Procellariiformes	Oceanitidae	*Nesofregetta fuliginosa*	Polynesian Storm-petrel	EN	Pelagic	storm-petrels
Procellariiformes	Oceanitidae	*Oceanites gracilis*	White-vented Storm-petrel	DD	Pelagic	storm-petrels
Procellariiformes	Oceanitidae	*Oceanites oceanicus*	Wilson's Storm-petrel	LC	Pelagic	storm-petrels
Procellariiformes	Oceanitidae	*Oceanites pincoyae*	Pincoya Storm-petrel	DD	Pelagic	storm-petrels
Procellariiformes	Oceanitidae	*Pelagodroma marina*	White-faced Storm-petrel	LC	Pelagic	storm-petrels
Sphenisciformes	Spheniscidae	*Aptenodytes forsteri*	Emperor Penguin	NT	Pelagic	penguins
Sphenisciformes	Spheniscidae	*Aptenodytes patagonicus*	King Penguin	LC	Pelagic	penguins
Sphenisciformes	Spheniscidae	*Eudyptes chrysocome*	Southern Rockhopper Penguin	VU	Pelagic	penguins
Sphenisciformes	Spheniscidae	*Eudyptes chrysolophus*	Macaroni Penguin	VU	Pelagic	penguins
Sphenisciformes	Spheniscidae	*Eudyptes moseleyi*	Northern Rockhopper Penguin	EN	Pelagic	penguins

Order	Family	Scientific name	Common name	2018 IUCN Red List Category	Pelagic / coastal	Group
Sphenisciformes	Spheniscidae	*Eudyptes pachyrhynchus*	Fiordland Penguin	VU	Pelagic	penguins
Sphenisciformes	Spheniscidae	*Eudyptes robustus*	Snares Penguin	VU	Pelagic	penguins
Sphenisciformes	Spheniscidae	*Eudyptes schlegeli*	Royal Penguin	NT	Pelagic	penguins
Sphenisciformes	Spheniscidae	*Eudyptes sclateri*	Erect-crested Penguin	EN	Pelagic	penguins
Sphenisciformes	Spheniscidae	*Eudyptula minor*	Little Penguin	LC	Pelagic	penguins
Sphenisciformes	Spheniscidae	*Megadyptes antipodes*	Yellow-eyed Penguin	EN	Pelagic	penguins
Sphenisciformes	Spheniscidae	*Pygoscelis adeliae*	Adélie Penguin	LC	Pelagic	penguins
Sphenisciformes	Spheniscidae	*Pygoscelis antarcticus*	Chinstrap Penguin	LC	Pelagic	penguins
Sphenisciformes	Spheniscidae	*Pygoscelis papua*	Gentoo Penguin	LC	Pelagic	penguins
Sphenisciformes	Spheniscidae	*Spheniscus demersus*	African Penguin	EN	Pelagic	penguins
Sphenisciformes	Spheniscidae	*Spheniscus humboldti*	Humboldt Penguin	VU	Pelagic	penguins
Sphenisciformes	Spheniscidae	*Spheniscus magellanicus*	Magellanic Penguin	NT	Pelagic	penguins
Sphenisciformes	Spheniscidae	*Spheniscus mendiculus*	Galapagos Penguin	EN	Pelagic	penguins
Suliformes	Phalacrocoracidae	*Gulosus aristotelis*	European Shag	LC	Coastal	cormorants and pelicans
Suliformes	Phalacrocoracidae	*Leucocarbo atriceps*	Imperial Shag	LC	Coastal	cormorants and pelicans
Suliformes	Phalacrocoracidae	*Leucocarbo bougainvilliorum*	Guanay Cormorant	NT	Coastal	cormorants and pelicans
Suliformes	Phalacrocoracidae	*Leucocarbo campbelli*	Campbell Shag	VU	Coastal	cormorants and pelicans
Suliformes	Phalacrocoracidae	*Leucocarbo carunculatus*	Rough-faced Shag	VU	Coastal	cormorants and pelicans
Suliformes	Phalacrocoracidae	*Leucocarbo chalconotus*	Stewart Shag	VU	Coastal	cormorants and pelicans
Suliformes	Phalacrocoracidae	*Leucocarbo colensoi*	Auckland Shag	VU	Coastal	cormorants and pelicans
Suliformes	Phalacrocoracidae	*Leucocarbo magellanicus*	Rock Shag	LC	Coastal	cormorants and pelicans
Suliformes	Phalacrocoracidae	*Leucocarbo onslowi*	Chatham Shag	CR	Coastal	cormorants and pelicans
Suliformes	Phalacrocoracidae	*Leucocarbo ranfurlyi*	Bounty Shag	VU	Coastal	cormorants and pelicans
Suliformes	Phalacrocoracidae	*Leucocarbo verrucosus*	Kerguelen Shag	LC	Coastal	cormorants and pelicans
Suliformes	Phalacrocoracidae	*Microcarbo coronatus*	Crowned Cormorant	NT	Coastal	cormorants and pelicans
Suliformes	Phalacrocoracidae	*Microcarbo melanoleucos*	Little Pied Cormorant	LC	Coastal	cormorants and pelicans
Suliformes	Phalacrocoracidae	*Nannopterum auritus*	Double-crested Cormorant	LC	Coastal	cormorants and pelicans
Suliformes	Phalacrocoracidae	*Nannopterum brasilianus*	Neotropical Cormorant	LC	Coastal	cormorants and pelicans

Order	Family	Scientific name	Common name	2018 IUCN Red List Category	Pelagic / coastal	Group
Suliformes	Phalacrocoracidae	*Nannopterum harrisi*	Flightless Cormorant	VU	Coastal	cormorants and pelicans
Suliformes	Phalacrocoracidae	*Phalacrocorax capensis*	Cape Cormorant	EN	Coastal	cormorants and pelicans
Suliformes	Phalacrocoracidae	*Phalacrocorax capillatus*	Japanese Cormorant	LC	Coastal	cormorants and pelicans
Suliformes	Phalacrocoracidae	*Phalacrocorax carbo*	Great Cormorant	LC	Coastal	cormorants and pelicans
Suliformes	Phalacrocoracidae	*Phalacrocorax featherstoni*	Pitt Shag	EN	Coastal	cormorants and pelicans
Suliformes	Phalacrocoracidae	*Phalacrocorax fuscescens*	Black-faced Cormorant	LC	Coastal	cormorants and pelicans
Suliformes	Phalacrocoracidae	*Phalacrocorax fuscicollis*	Indian Cormorant	LC	Coastal	cormorants and pelicans
Suliformes	Phalacrocoracidae	*Phalacrocorax neglectus*	Bank Cormorant	EN	Coastal	cormorants and pelicans
Suliformes	Phalacrocoracidae	*Phalacrocorax nigrogularis*	Socotra Cormorant	VU	Coastal	cormorants and pelicans
Suliformes	Phalacrocoracidae	*Phalacrocorax punctatus*	Spotted Shag	LC	Coastal	cormorants and pelicans
Suliformes	Phalacrocoracidae	*Phalacrocorax varius*	Great Pied Cormorant	LC	Coastal	cormorants and pelicans
Suliformes	Phalacrocoracidae	*Poikilocarbo gaimardi*	Red-legged Cormorant	NT	Coastal	cormorants and pelicans
Suliformes	Phalacrocoracidae	*Urile pelagicus*	Pelagic Cormorant	LC	Coastal	cormorants and pelicans
Suliformes	Phalacrocoracidae	*Urile penicillatus*	Brandt's Cormorant	LC	Coastal	cormorants and pelicans
Suliformes	Phalacrocoracidae	*Urile urile*	Red-faced Cormorant	LC	Coastal	cormorants and pelicans
Suliformes	Fregatidae	*Fregata andrewsi*	Christmas Frigatebird	CR	Pelagic	frigatebirds and tropicbirds
Suliformes	Fregatidae	*Fregata aquila*	Ascension Frigatebird	VU	Pelagic	frigatebirds and tropicbirds
Suliformes	Fregatidae	*Fregata ariel*	Lesser Frigatebird	LC	Pelagic	frigatebirds and tropicbirds
Suliformes	Fregatidae	*Fregata magnificens*	Magnificent Frigatebird	LC	Pelagic	frigatebirds and tropicbirds
Suliformes	Fregatidae	*Fregata minor*	Great Frigatebird	LC	Pelagic	frigatebirds and tropicbirds
Suliformes	Sulidae	*Morus bassanus*	Northern Gannet	LC	Pelagic	gannets and boobies
Suliformes	Sulidae	*Morus capensis*	Cape Gannet	EN	Pelagic	gannets and boobies
Suliformes	Sulidae	*Morus serrator*	Australasian Gannet	LC	Pelagic	gannets and boobies
Suliformes	Sulidae	*Papasula abbotti*	Abbott's Booby	EN	Pelagic	gannets and boobies
Suliformes	Sulidae	*Sula dactylatra*	Masked Booby	LC	Pelagic	gannets and boobies
Suliformes	Sulidae	*Sula granti*	Nazca Booby	LC	Pelagic	gannets and boobies
Suliformes	Sulidae	*Sula leucogaster*	Brown Booby	LC	Pelagic	gannets and boobies
Suliformes	Sulidae	*Sula nebouxii*	Blue-footed Booby	LC	Pelagic	gannets and boobies

Order	Family	Scientific name	Common name	2018 IUCN Red List Category	Pelagic / coastal	Group
Suliformes	Sulidae	*Sula sula*	Red-footed Booby	LC	Pelagic	gannets and boobies
Suliformes	Sulidae	*Sula variegata*	Peruvian Booby	LC	Pelagic	gannets and boobies

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930 Appendix 2: List of threats considered in the analyses (Table A.2.1.), and correspondence with the original IUCN Red List
931 threats classification scheme (IUCN, 2012) (Table A.2.2.)

932

933 Table A2.1. List of threats considered in the study. Adapted from IUCN (2012) and Salafsky et al. (2008).

Threat	IUCN Level 1	Source	Description (adapted from Salafsky et al. 2008)
Agriculture	Agriculture & Aquaculture	Terrestrial	Threats from farming and ranching as a result of agricultural expansion and intensification, including silviculture
Aquaculture	Agriculture & Aquaculture	Marine	Threats from farming as a result of aquaculture and mariculture expansion and intensification (e.g. marine & freshwater aquaculture)
Bycatch	Biological Resource Use	Marine	Threats from the unintentional effects of the consumptive use of "wild" biological resources resulting in direct mortality or loss of reproductive output
Climate change & severe weather	Climate Change & Severe weather	-	Long-term climatic changes that may be linked to global warming and other severe climatic or weather events outside the natural range of variation that could eliminate a vulnerable species or habitat
Diseases	Invasive & Other Problematic Species, Genes & Diseases	Terrestrial or marine[1]	Threats from non-native and native pathogens/microbes that have or are predicted to have harmful effects on biodiversity following their introduction, spread and/or increase in abundance
Disturbance	Biological Resource Use, Human Intrusions & Disturbance	Terrestrial or marine[1]	Threats from human activities that alter, destroy and disturb habitats and species associated with non-consumptive uses of biological resources
Energy production & mining	Energy Production & Mining	Terrestrial or marine[1]	Threats from production of nonbiological resources
Geological events	Geological Events	Terrestrial	Threats from catastrophic geological events
Hunting/trapping	Biological Resource Use	Terrestrial or marine[1]	Threats from consumptive use of "wild" biological resources including deliberate harvesting effects; also persecution or control of specific species
Invasive alien species	Invasive & Other Problematic Species, Genes & Diseases	Terrestrial	Threats from non-native plants or animals that have or are predicted to have harmful effects on biodiversity following their introduction, spread and/or increase in abundance
Light pollution	Pollution	Terrestrial or marine[1]	Threats from excess energy (light)
Logging & wood harvesting	Biological Resource Use	Terrestrial	Threats from harvesting trees and other woody vegetation for timber, fibre, or fuel
Natural system modifications	Natural System Modifications	Terrestrial	Threats from actions that convert or degrade habitat in service of "managing" natural or seminatural systems, often to improve human welfare

Threat	IUCN Level 1	Source	Description (adapted from Salafsky et al. 2008)
Overfishing	Biological Resource Use	Marine	Threats from unintentional effects of consumptive use of "wild" biological resources resulting in resource competition or indirect impacts on the ecosystem
Pollution	Pollution	Terrestrial or marine[1]	Threats from introduction of exotic and/or excess materials or energy (except light) from point and nonpoint sources
Problematic native species	Invasive & Other Problematic Species, Genes & Diseases	Terrestrial	Threats from native plants or animals that have or are predicted to have harmful effects on biodiversity following their spread and/or increase in abundance
Residential & commercial development	Residential & Commercial Development	Terrestrial	Human settlements or other non-agricultural land uses with a substantial footprint
Transportation & service corridors	Transportation & Service Corridors	Terrestrial or marine[1]	Threats from long, narrow transport corridors and the vehicles that use them including associated wildlife mortality

934 [1] Classification into terrestrial or marine made case by case, based on the references consulted (e.g. terrestrial if occurring on land, marine if at sea)

935 Table A2.2. Correspondence between the threats considered in the analyses (see A2.1.) and the original IUCN Red List threats classification
936 scheme (IUCN, 2012)

Threat	IUCN Level 1	IUCN Level 2	IUCN Level 3	Source	Notes
Agriculture	Agriculture & Aquaculture	Annual & Perennial Non-Timber Crops	Shifting Agriculture, Small-holder Farming, Agro-Industry Farming, Scale Unknown/Unrecorded	Terrestrial	
		Wood & Pulp Plantations	Small-holder Plantations, Agro-Industry Plantations, Scale Unknown/Unrecorded	Terrestrial	
		Livestock Farming & Ranching	Nomadic Grazing, Small-Holder Grazing, Ranching or Farming, Agro-Industry Grazing, Ranching or Farming, Scale Unknown/Unrecorded	Terrestrial	
Aquaculture	Agriculture & Aquaculture	Marine & Freshwater Aquaculture	Subsistence/Artisanal Aquaculture, Industrial Aquaculture, Scale Unknown/Unrecorded	Marine	
Bycatch	Biological Resource Use	Fishing & Harvesting Aquatic Resources	Unintentional effects: subsistence/small scale (species being assessed is not the target) [harvest], Unintentional effects: large scale (species being assessed is not the target) [harvest]	Marine	stress="species mortality"
Climate change & severe weather	Climate Change & Severe Weather	Droughts	[No level 3 threats under Climate Change & Severe Weather]		
		Habitat Shifting & Alteration			
		Other Impacts			
		Storms & Flooding			
		Temperature Extremes			
Diseases	Invasive & Other Problematic Species, Genes & Diseases	Invasive non-native/alien species/diseases	Unspecified Species, Named Species	Terrestrial	species=any kind of disease
		Problematic native species/diseases	Unspecified Species, Named Species	Terrestrial	species=any kind of disease
		Problematic species/disease of unknown origin	Unspecified Species, Named Species	Terrestrial, marine (algal blooms)	species=any kind of disease
		Viral/prion-induced diseases	Named “Species” (Disease), Unspecified “Species” (Disease)	Terrestrial	
		Diseases of unknown cause		Terrestrial	
Disturbance	Biological Resource Use	Fishing & Harvesting Aquatic Resources	Unintentional effects: subsistence/small scale (species being assessed is not the target) [harvest], Unintentional effects: large scale (species being assessed is not the target) [harvest]	Marine	
		Recreational Activities		Terrestrial	

Threat	IUCN Level 1	IUCN Level 2	IUCN Level 3	Source	Notes
	Human intrusions & disturbance	Work & Other Activities		Terrestrial	
Energy production & mining	Energy production & mining	Mining & Quarrying		Marine	
		Oil & Gas Drilling		Marine	
		Renewable Energy		Marine	
Geological events	Geological events	Avalanches/Landslides		Terrestrial	
		Volcanoes		Terrestrial	
Hunting/trapping	Biological Resource Use	Fishing & Harvesting Aquatic Resources	Persecution/Control	Marine	
		Hunting & Collecting Terrestrial Animals	Intentional use (species being assessed is the target), Persecution/Control, Unintentional effects (species being assessed is not the target)	Terrestrial, marine[1]	
Invasive alien species	Invasive & Other Problematic Species, Genes & Diseases	Invasive Non-Native/Alien Species/Diseases	Unspecified Species, Named species	Terrestrial	species=any non-disease
Light pollution	Pollution	Excess Energy	Light Pollution	Terrestrial, marine[1]	
Logging & wood harvesting	Biological Resource Use	Gathering Terrestrial Plants	Unintentional effects (species being assessed is not the target)	Terrestrial	
		Logging & Wood Harvesting	Unintentional effects: subsistence/small scale (species being assessed is not the target) [harvest], Unintentional effects: large scale (species being assessed is not the target) [harvest]	Terrestrial	
Natural system modifications	Natural System Modifications	Dams & Water Management/Use	Abstraction of Surface Water (agricultural use), Abstraction of Surface Water (domestic use), Abstraction of Surface Water (unknown use), Dams (size unknown), Large Dams	Terrestrial	
		Fire & Fire Suppression	Increase in Fire Frequency/Intensity, Trend Unknown/Unrecorded	Terrestrial	
Overfishing	Biological Resource Use	Fishing & Harvesting Aquatic Resources	Unintentional effects: subsistence/small scale (species being assessed is not the target) [harvest], Unintentional effects: large scale (species being assessed is not the target) [harvest]	Marine	stress="indirect ecosystem effects" or "competition"
Pollution	Pollution	Agricultural & Forestry Effluents	Herbicides and Pesticides, Nutrient Loads	Terrestrial	
		Domestic & Urban Waste Water	Type Unknown/Unrecorded	Terrestrial	
		Garbage & Solid Waste		Terrestrial	

Threat	IUCN Level 1	IUCN Level 2	IUCN Level 3	Source	Notes
		Industrial & Military Effluents	Oil Spills, Seepage from Mining, Type Unknown/Unrecorded	Terrestrial, marine (oil spills)	
Problematic native species	Invasive & Other Problematic Species, Genes & Diseases	Problematic Native Species/Diseases	Unspecified Species, Named Species	Terrestrial	
Residential & commercial development	Residential & Commercial Development	Commercial & Industrial Areas		Terrestrial	
		Housing & Urban Areas		Terrestrial	
		Tourism & Recreation Areas		Terrestrial	
Transportation & service corridors	Transportation & Service Corridors	Roads & Railroads		Terrestrial	
		Shipping Lanes		Marine	
		Utility & Service Lines		Terrestrial	

[1] Classification of terrestrial or marine made case by case, based on the references consulted (e.g. terrestrial if occurring at the colony, marine if at-sea)

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Appendix 3: Supporting figures

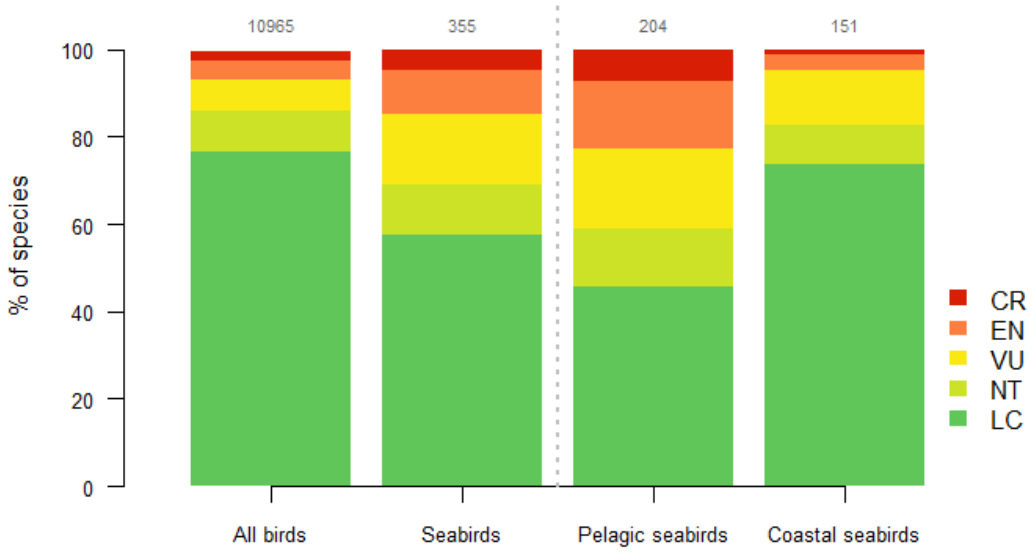

Figure A1: IUCN Red List status of all extant bird species, all seabirds, and pelagic and coastal seabird species (based on BirdLife International, 2018). Values atop bars indicate the number of species (species classified as "Data Deficient" (56, including 4 seabird species (all pelagic) are not shown). CR = Critically Endangered; EN = Endangered; VU = Vulnerable; NT = Near Threatened; LC = Least Concern.

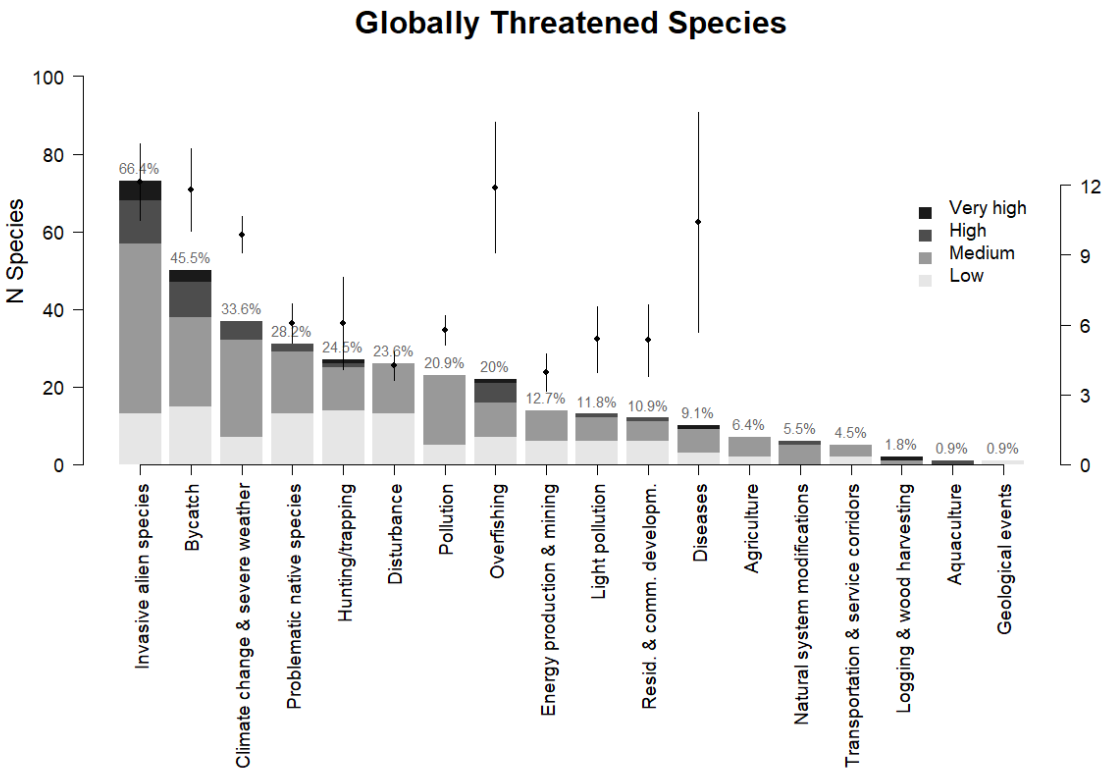

Figure A2: Ongoing threats to globally threatened seabird species (Critically Endangered, Endangered or Vulnerable). Left y axis: total number of species affected; Right y axis: average impact ± SE. Values atop bars indicate the percentage of species affected (n=110).

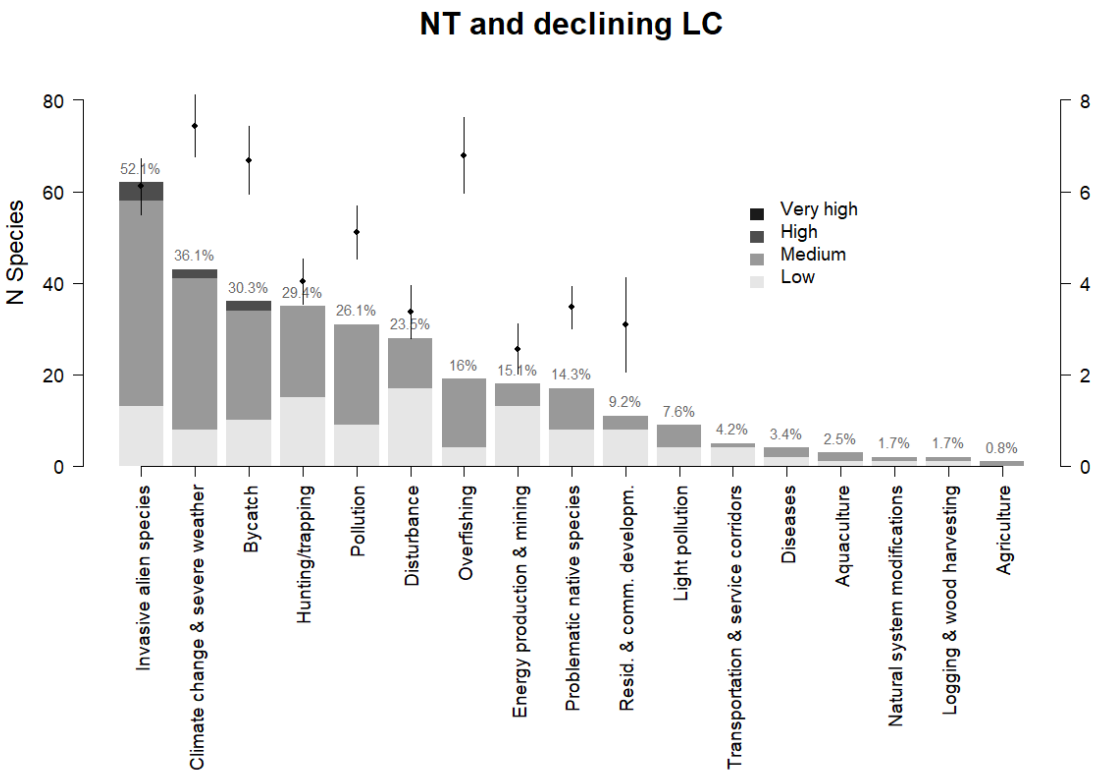

Figure A3: Ongoing threats to Near Threatened (NT) and declining Least Concern (LC) seabird species. Left y axis: total number of species affected; Right y axis: average impact ± SE. Values atop bars indicate the percentage of species affected (n=119).

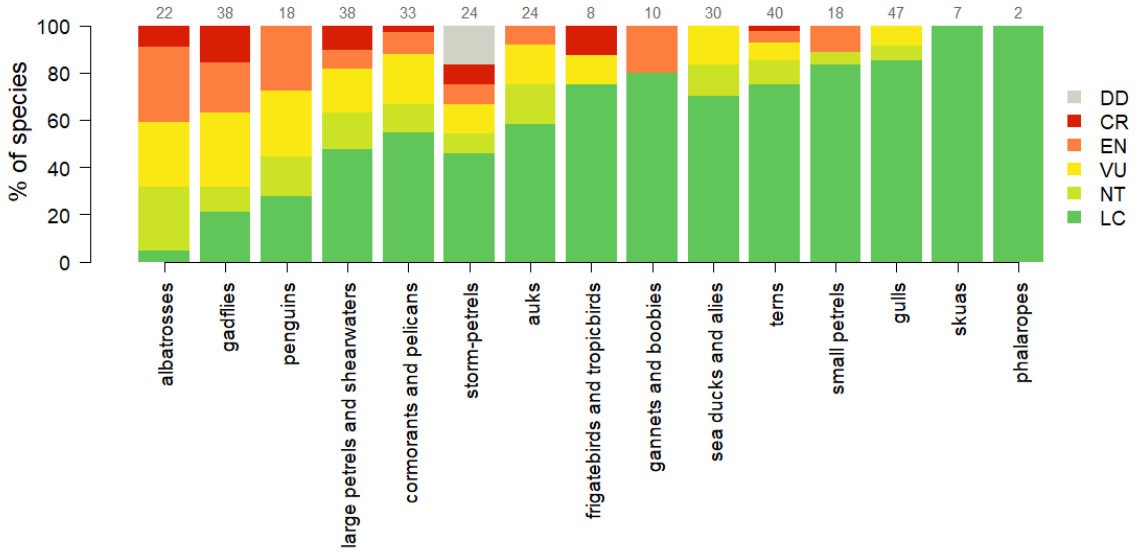

Figure A4: IUCN Red List status for each group of seabird species. Values atop bars indicate the number of species per group. DD = Data Deficient; CR = Critically Endangered; EN = Endangered; VU = Vulnerable; NT = Near Threatened; LC = Least Concern.

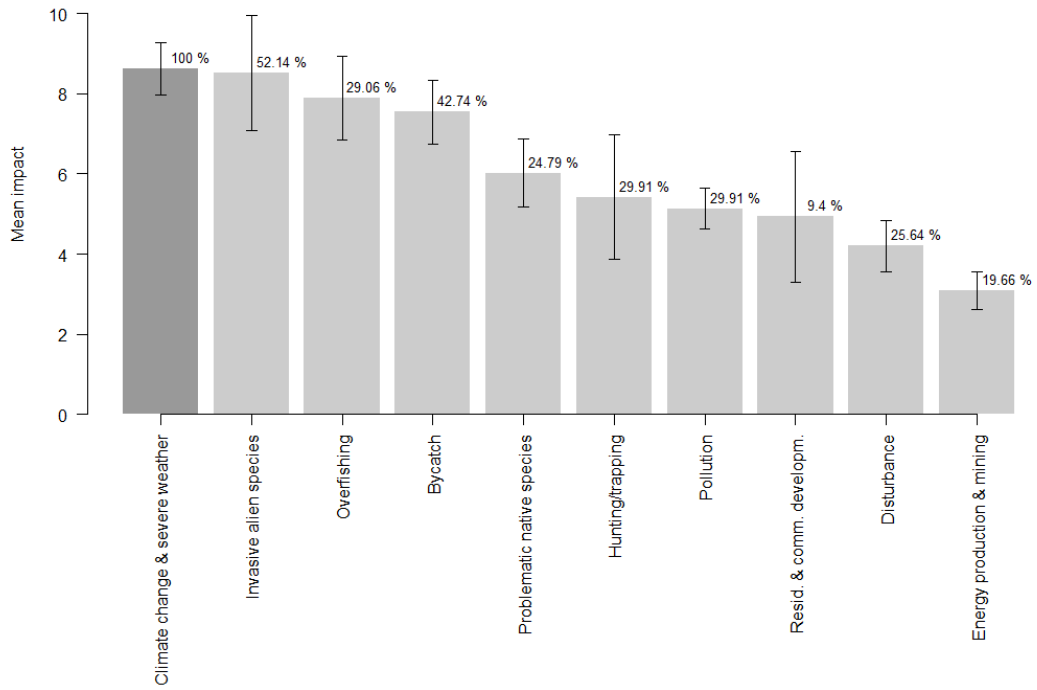

Figure A5: Mean impact (± EP) of threats co-occurring with climate change/severe weather (% indicate the percentage of species affected both by climate change/severe weather and each threat; only threats affecting more than 10 species are indicated)

References

BirdLife International, 2018. IUCN Red List for birds [WWW Document]. URL http://www.birdlife.org (accessed 10.12.18).